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EASTWOOD MULTIPLE ARCHED DAM AT BIG BEAR VALLEY, SHOWING OLD DAM STILL IN PLACE. THE NEW DAM INCREASED THE RESERVOIR CAPACITY 308 PER CENT FOR THE SAME COST AS THE OLD DAM AND HAS A SAFETY FACTOR 200 PER CENT GREATER. (See page 175.)

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EDITORIAL

IN view of Great Britain's refusal to participate in the Panama-Pacific Exposition for the reason that the results achieved would not justify the outlay, it is interesting to note that a movement is under way to raise $500,000 to enable Great Britain to make a better showing at the Berlin Olympic games than was made at Stockholm. It would appear that athletic supremacy is of greater moment than the exploitation of Great Britain's industries. Perhaps Mr. Kipling's poem anent the "Flanneled fools at the wickets and the muddled oafs at the goals" was not so wide of the mark after all.

SLIPPERY pavements in San Francisco during wet weather will soon be a thing of the past, if the new non-skid pavement about to be tried on Market street proves successful. The method was devised by Mr. D. J. McCoy, superintendent of streets, and consists in heating the surface of the asphalt and then applying a layer of coarse sand which is rolled into the pavement. This affords a surface sufficiently rough to prevent horses from slipping and automobiles from skidding in wet weather. Experiments already tried with this pavement on several city streets are said to have met with marked success.

AN interesting sequel to the troubles of the New York, New Haven & Hartford railroad is the announcement that Sanderson and Porter have acquired the western Massachusetts electric system formerly owned by this company. Sanderson and Porter have made a long and successful record in the administration and construction of public utilities and there is no doubt that many improvements in service and equipment may be expected under the new régime.

IN a recent discussion of the myriawatt before the American Society of Mechanical Engineers, one of the members present objected to its adoption on the ground that it is an old unit with a self-explanatory term. He recommends as a substitute a 'vim' system embracing in all six new terms, namely, the 'vim,' 'kilovim,' 'volt-vamp,' 'therm,' 'vamp,' and 'vohm.' But is not this system also open to the reproach of being nearly intelligible? 'Vim,' in its accepted meaning, may be applied to a variety of uses, often to advantage. In fact we recall its frequent use in an advertising campaign extolling the merits of a certain breakfast food. However, if we must have these things, would it not simplify matters if poetry could be utilized as a fillip to the memory and assist our mental digestive apparatus. How will this do?

'Twas therm-ish, and the kilovim
  Did vamp and vohm with childish glee,
While vim and volt-vamp sang a hymn
  Of praise, of the A. S. M. E.

INACCURACIES in newspaper reports on technical subjects are the usual thing, but an item published in a Los Angeles daily describing a new plant for the manufacture of gasoline from casing-head gas for the Olinda Gasoline Company in the Whittier fields goes beyond the usual limit. We learn from the head lines that the new

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plant 'consumes' 1000 feet of gas and turns out 25,000 gallons of gasoline per day. On reading further, however, it appears that the figure should be 1,000,000 feet, a few zeros having apparently fallen by the wayside. The word 'consumed,' however, is still applied in the same haphazard fashion. But most marvelous of all is the statement that the cost of operation is cut down "fully 100 per cent" as compared with other methods. Perhaps when everything is in thorough working order these results may be improved upon, and the day of 101 per cent efficiency, both economic and mechanical, is at hand.

MEMBERS of the Kern County Protective Association met in San Francisco on August 13 to consider their future course with regard to safeguarding the oilfields. It was hoped that the passage of the Sutherland oil land protection measure, would render unnecessary any further work on the part of the Association. The Governor having failed to give his approval, however, has emphasized the necessity for the continuation of the good work that has already been done with the aid of funds contributed by the individual members. The sense of the meeting was, in effect, that the work should be continued as before and that further questions could be dealt with as deemed advisable at future meetings. The upkeep of the catch basin will be maintained by the same committee and steps will be taken to prevent the dregs from being washed into the lake and damaging property owners. Every oil producer should lend his financial and moral support to this Association in order that it may continue its work for the good of the industry, as it is only through coöperation that success may be achieved.

WALL STREET is said to be a small portion of lower Manhattan island consisting of a multitude of stock issues entirely surrounded by water. This perhaps is the reason why the *Wall Street Journal*, jealous of San Francisco's effort to acquire a water supply of its own, 'views with alarm' the Hetch-Hetchy project. Aside from some inconsequential remarks the only real reason apparent for the *Journal's* disapproval is its statement that other sources of supply are available nearer San Francisco, thus indicating that the reports of Mr. John R. Freeman and the Board of United States Army Engineers to the contrary are considered of little or no consequence. It seems a pity that good ink and paper should be wasted in the expression of opinions that show an utter disregard for the conclusions of independent engineers whose exhaustive reports and investigations form the basis of San Francisco's claim for consideration on the part of the Government.

AMERICAN ownership of foreign ships is far more common than is generally recognized. When the English Admiralty proposed to place guns on the liners, it was promptly discovered that an astonishing number were American-owned. Even so typical an English concern as Shaw, Savill & Albion Company, Limited, running boats from England to Australia, is in large part owned in the United States. On the Pacific Coast there are the Dollar and the Grace boats, both run under the English flag, but American owned, to say nothing of the Standard Oil fleet. Recently the Hamburg-American Company undertook to compete with the United Fruit Company in shipping bananas to Germany. It is now announced that it has given up and sold

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its steamers to the American firm. The United Fruit Company is a typical American 'trust,' built up by a group of active young men who saw the opportunities in consolidating and expanding the business of competing fruit lines. Aside from the steamers running from the banana belt to the United States and South America, this company now has 16 vessels carrying fruit to England and is shortly to have 6 in the line to Germany. The disappearance of the American merchant marine is more apparent than real.

METHODS of determining power rates charged to corporations seeking grants of water rights from the Government have been in controversy, and a standard basis has been announced by Mr. Franklin K. Lane, Secretary of the Interior. In considering a power project on the Pend Oreille river in Washington, five conditions have been cited determining the principles to be followed. They are:

First—The greater development of horse-power the lower the charge per horse-power to be made on the part of the Government. This is intended to secure the full use of the stream.

Second—The lower the rate to consumers the lower the charge on the part of the Government.

Third—No charge whatever for a period of five or ten years during which the power company is finding its market.

Fourth—Acceptance as a public utility of the state's jurisdiction over intrastate rates and services, and of federal jurisdiction over interstate rates and services.

Fifth—Absolute prohibition of combination or monopoly and the right of revocation on the part of the Government in the event that it is established to the satisfaction of the Secretary of the Interior or the courts that such combination has been made or that prices have been fixed by agreement with competing plants.

These principles are fair to both producer and consumer, and should help to assure stability to capital invested in power enterprises.

Petroleum Exhibit at the Panama-Pacific Exposition

Petroleum and its by-products daily are playing a more important part in our economic and industrial development. The average man is more or less familiar with the gasoline and kerosene of commerce, as he sees them applied to the ministration of his daily needs, but of the many evolutionary stages through which they go before finding a way into the automobile or kitchen he is profoundly ignorant. The approach of the time for holding the Panama-Pacific Exposition calls attention to the great opportunity that is afforded oil producers and refiners to prepare an exhibit that will at once do credit to the magnitude of the industry and at the same time have an educational value the extent of which can hardly be overestimated. Such an exhibit should be participated in by every oil producing district in the world, and not consist merely of a few bottles of petroleum, but include chiefly production methods and the solution of the problems incident thereto. If all the producing districts in the United States could be induced to take the matter up in earnest, an opportunity for a comparison of methods would be afforded that would be of incalculable benefit to those directly concerned, and of wide interest to the general public. While it is obviously difficult to reproduce pumping and drilling on a full sized scale, yet the

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fundamental principles of oil production can be shown through models and stereographs even more clearly than by a full sized rig in operation. Such an exhibit should include:

Plaster cast models of geological cross-sections, accurately drawn to scale, showing formations properly colored to represent typical conditions in all oil-producing districts.

Glass and wood models, showing oil and water formations and their relation to superficial topography.

Glass models of oil wells to scale, showing all casings mounted in actual formations, with water percolating through the water sands, and oil being extracted from the oil sands.

Topographic relief casts in plaster, showing relations of producing and non-producing formations from a geological standpoint.

Models of standard and rotary drilling rigs, preferably in operation.

Models of pumping appliances of various kinds, also in operation.

Exhibit of prime movers for operating oil-producing appliances, including a glass model air-lift pump in operation.

General exhibit of tools and appliances used in oil production.

Practically all of the larger oil companies have comprehensive field data of their own property which could be collected for the purpose of preparing the exhibits. Through the coöperative effort of all of the important oil producers in each district, the cost of preparing suitable exhibits would impose a comparatively light burden upon each individually. It is fitting that such a movement should initiate in California for two reasons, one that the Exposition will benefit this state more than any other section of the country, and second, that California alone is now producing more than one-third of the total production of petroleum in the United States. We have already mentioned the benefits that would be derived by spectators through an exhibit such as this, but, if anything, the chief beneficiaries would be the oil companies themselves. Publicity that is educational is the best possible kind. New companies, in the final analysis, must rely upon the people as a whole for financial support of new enterprises. An exhibit that will aid toward a better understanding of just what oil production means, will stimulate interest on the part of the general public and increase confidence in the stability of the industry. It will also convey a better understanding to present holders of securities of the true significance of production methods that are now to them little more than a mere jumble of meaningless words. Anyone who doubts the attraction of such an exhibit should stand on the corner of Pine and Sansome streets, San Francisco, and observe the number of passers-by who linger before the show-windows of the Standard Oil Company. There, just inside the window, is a miniature oil farm in operation, complete in every detail. A standard rig is industriously drilling, and a number of wells are being pumped by a jack. To prepare such an exhibit undoubtedly was expensive. That the Standard Oil Company considers it good business goes without saying. And now what are the oil men of California going to do to see that their industry is given due representation at the Panama-Pacific Exposition? There has recently come into existence a new profession, petroleum engineering. The International Engineering Congress is to meet in San Francisco in 1915, thus affording a great opportunity for the exploitation of California's vast oil resources before this representative gathering.

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REVIEW OF THE MONTH

BUSINESS conditions have shown improvement during the month. Money is still tight, although the disposal of $4,000,000 of Huntington Land & Improvement Co. short-term notes within a few days of their having been placed on sale may be taken as an indication that money is available when sufficient inducement is offered. In the meantime the dehydration of securities goes merrily on, while government regulation of public utilities renders the opportunities for the accumulation of swollen fortunes by the rising generation few and far between.

THE action of the California Railroad Commission with regard to Wells Fargo & Company Express rates may be regarded as another capital operation on the high cost of living. The reason for the existence of this company has always been more or less of a mystery to the average man. Why the transportation companies should sublet an undoubtedly valuable portion of what is ostensibly their business seemed more than passing strange, but now that the 'lid' has been unceremoniously removed, we may peep within and contemplate the vista spread before us.

THE Railroad Commission was not satisfied merely to order sweeping reductions in rates that will amount to about $750,000 annually, but has declared in no uncertain terms that the express companies are parasites on the railroads, and that, if express service is a public necessity, there is no reason why the carriers cannot furnish and maintain "the comparatively small amount of additional terminal equipment necessary to carry on the pick-up and delivery business of the Express Company." The decision states also in effect that on an investment of $613,000 in California, the Express Company has been earning $842,000 per year; that intercorporate relationship between the railroads and the Express Company makes fraud possible upon the railroad and the public. It also appears that while the Express Company pays to the Santa Fe railroad 55 per cent of its gross earnings for the privileges it enjoys, it pays to the Southern Pacific Company but 40.8 per cent of its gross earnings for a like service. The Santa Fe railroad has complained that its remuneration is not adequate, although no complaint has been made by the Southern Pacific Company. The Commission finds, however, that the Santa Fe or its stockholders are not interested in Wells Fargo & Company Express, while the contrary is the case with the Southern Pacific Company. In fact, it is said that the estate of the late E. H. Harriman owns large holdings in the Wells Fargo company. If 55 per cent of the Wells Fargo gross income is not profitable to the Santa Fe Company, 40 per cent could only be profitable to the Southern Pacific Company on the basis of its obtaining the bulk of the express traffic to and from points at which both railroads touch.

SEGREGATING the business wholly within the state of California from the interstate business, the Railroad Commission reaches the following conclusions as to the annual earnings of

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Wells Fargo & Company Express in this state:

Gross earnings per year	$4,508,436.18
Paid to railroads	1,937,019.73
Balance	$2,571,416.45
Operating expenses	1,729,318.91
Profit for the year	$ 842,097.54
Value of Company's property used in California business	$613,233.65

Rate on return per annum, 136 per cent.

Net earnings at 10 per cent. $61,323.00

Reduction in net earnings, 90 per cent.

REDUCTIONS in rates charged by express companies are by no means confined to California. On August 4 the Interstate Commerce Commission ordered reductions in interstate express rates that will cut the companies' gross revenue approximately 16 per cent, or in round numbers fully $26,000,000 annually. The change involves a modification of the present graduated scale of parcel rates to the so-called 'block' or zone system now used in connection with the parcel post. This change simplifies the rate situation greatly, as it cuts the total number of rates from 900,000,000 to less than 650,000. The block or zone system divides the United States into 950 blocks averaging 2500 square miles each, and it is believed that an extension of this system to freight traffic also may prove to be a solution to the ever-recurring question of freight rates.

AS was to be expected, the express companies have protested strenuously against the enforcement of the Commission's order. The argument put forth was that, as the parcel post had so diminished the revenue of the express companies on parcels on 11 pounds and under, reduction of their remaining revenue would put them out of business altogether. It was pointed out by the Commission, in answer to this, however, that if the protest were allowed it would be equivalent, by permitting higher rates, to taking from the shippers of the country all the benefit they were receiving from the parcel post.

SURPRISE has been expressed among oilmen at the action taken by the Standard Oil Company with regard to the oil pipe-line common-carrier law passed at the last session of the State Legislature. It was confidently expected by the other companies owning and operating oil pipe-lines that the Standard could be relied upon to institute proceedings to test the legality of the common-carrier law. Now that the Standard has complied with the law and filed a schedule of rates with the Railroad Commission, it has fallen to the lot of the Southern Pacific Company, through its subsidiaries, the Associated Pipe Line Company and the Kern Trading & Oil Company, to see what can be done to relieve the situation.

BY filing a bill of equity before the United States District Court, the attorneys for the Southern Pacific Company have attacked the constitutionality of the act on the ground that its provisions are confiscatory. In a statement made by the Standard Oil Company, attention is called to chapter 286 of the act providing that all carriers operating pipe-lines more than thirty-five miles in length (otherwise than as common carriers), and which pipe-lines cross the public highways, must obtain a license for which they shall pay $250 per year, and must further pay to the state a license fee

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or exaction of 50 cents per barrel for every barrel of oil transported in pipe-lines crossing the highways; also that no further crossing of the highways may be made by pipe-lines not operated as common carriers. As these fees are more than the value of the greater part of the oil transported, it would appear that the companies operating pipe-lines may choose between operating as common carriers or going out of business.

WHEN Congress passed a law declaring interstate pipe-lines common carriers and placing them under control of the Interstate Commerce Commission, the Prairie Oil & Gas Company carried the matter before the Commerce Court, which declared the law unconstitutional, the court holding that the pipe-lines were private property and as such could not be forced to become common carriers. Appeal from this decision was taken and the case is now pending before the United States Supreme Court. If this case establishes a precedent that may be applied in California, it would appear that the pipe-line companies have grounds for hope. In the meantime, in view of the modern tendency toward the regulation of everybody and everything, it is difficult to determine if there is such a thing as private property.

AFTER many 'false alarms' word has been received that the Royal Dutch-Shell oil interests have actually obtained a foothold in the California oilfields. Confirmation of the sale of the property of the California Oilfields, Ltd., was received in San Francisco on August 15, and it is believed that announcement of the purchase of other properties will soon follow. The California Oilfields, Ltd., is an English company and is managed by Balfour, Guthrie & Company, of San Francisco. The company has a daily production of approximately 14,000 barrels, which has been sold to the Standard Oil Company under contract which is about to expire. The purchase price of the company's holdings is said to have been $13,000,000, which, as the capital stock is but £500,000, of which £400,000 has been issued, and a bond issue of £240,000 is outstanding, should return the stockholders a handsome profit. The company was organized in 1901 and paid dividends of 30 per cent in 1906. Since then the yearly dividend rate has ranged between 30 and 40 per cent. The present land holdings amount to 6240 acres in the Coalinga fields, of which 4480 acres was secured in 1901 and the remainder in 1906.

THE pipe-line common-carrier situation in California, as it stands at present, seems to have worked out remarkably well from the standpoint of the Royal Dutch-Shell interests. The purchase of the site of the old Peyton Chemical Works is said to have been made for the purpose of supplying a suitable location for a refinery. The pipe-line of the Standard Oil Company from the Coalinga fields passes within a few miles of the old Chemical Works site, thus rendering it possible for the Shell interests to transport their oil from field to refinery over the Standard pipe-line.

SAN FRANCISCO, by the action of the voters on Tuesday, August 26, has ratified a bond issue of $3,500,000 for making extensions to the municipal street railway system, and thus assures adequate transportation facilities for the Panama-Pacific Exposition. An attempt was made in December last to provide for extension to the lines of the United Railroads for the same pur-

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pose, but as a charter amendment was necessary before the franchise could be extended to cover the needed improvements; the measure was defeated at the polls. The feeling that undoubtedly exists among the rank and file of the people against the United Railroads caused the voters to overlook the real purpose of the charter amendment and regard it solely as a measure to aid a corporation that had fallen into disrepute. That this feeling exists in San Francisco seems to have been recognized by the interests controlling the United Railroads, as announcement has been made of the appointment of Mr. Jesse R. Lilienthal of San Francisco to succeed Mr. Patrick Calhoun as president of the company. Mr. Lilienthal is an attorney of high personal standing who has given much time and attention to affairs of public welfare, and it is believed that his appointment will help materially in restoring good feeling between the company and the community which it serves.

THE rate controversy between the city of Spokane and the Spokane Gas Company has been settled by a compromise that terminates litigation for the present. The disagreement started in May 1912 when the city council attempted to cut the rate from $1.50 to $1.20 per 1000 cubic feet. As the company refused to accept the reduced rate, the matter was laid before the Public Service Commission, which made a valuation of the property, and, after a hearing held in April last, fixed the rate at $1.40, which the company has now accepted. It was ascertained during the hearing that the company had been paying but 1 per cent of its gross earnings as a tax on the original franchise granted in 1902, and had ignored the provisions of the later franchise granted in 1904 that stipulated a payment of 2 per cent tax on the gross earnings. The Supreme Court, when called upon to pass upon the matter, decided that the old franchise was dead, and therefore that the company was operating solely upon the later franchise and liable for the 2 per cent tax. This decision adds $16,000 to the city treasury and settles the rate question until October 1914, when the matter may be taken up again.

PROSPECTIVE exhibitors at the Panama-Pacific Exposition will be interested in learning that the Department of Works has issued a book of rules and regulations for the guidance of contractors and exhibitors, and which is now ready for distribution. The book has been carefully compiled and shows evidence of close attention and study. Full details regarding prices for service of various kinds to exhibitors are given as well as forms for contractors' building, plumbing, and electric wiring permits. Exhibitors and contractors will do well to secure a copy of this book without delay and thereby avoid any confusion that might arise due to a misunderstanding or lack of understanding of the rules and regulations.

DISAPPOINTMENT has been expressed over the decision by the assistant attorney general of the state of Washington that the proposed debt to be incurred by the state in payment of its share of $80,000, the price of the Lewiston-Clarkston bridge, would be invalid. The people of Clarkston and Asotin county hoped that the tolls would be lifted on September 2 through the joint purchase of the bridge by the states of Idaho and Washington from the Lewiston-Clarkston Improvement Co. Bonds will probably be issued to provide funds for the project.

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The Ultimate Dam

By JOHN S. EASTWOOD*

IN discussing the Moreno dam, designed and built by M. M. O'Shaughnessy for the Southern California Water Company, George L. Dillman lays down what he aptly terms "the great hydraulic principle" for the design and erection of hydraulic works. This he expresses as follows: "Briefly stated, the principle is this, construct one impervious surface, and build the rest of the structure to support that surface. If this surface should not be water-tight, make it as nearly so as possible, in order that seepage or leakage will not be allowed to accumulate pressure against some other surface, or do other damage in getting away.

"In the case of masonry or concrete dams, the particular part to make tight is the up-stream face. If this is tight and supported, the result will be a dam; otherwise, a failure. This support is: (1) solid masonry or concrete, the result being the so-called uniform sectioned type; or (2) buttresses of masonry or concrete, resulting in the multiple arch dam, safer and more economical; or (3) a mass of loose rock, as in the present case, resulting in a stable structure."

This statement of the great hydraulic principle is the essence of common sense.

Next in order after the establishment of this basic principle comes the problem of its execution in actual practice. Nowhere is its application more vitally important than in the design and erection of dams. The design of a dam should be such as to achieve the results of this basic principle with the maximum of safety, permanence, and economy. These conditions should be considered in the order named: safety first, for on it depend human life and property; permanence next, concerning the use of the best materials nature has given us for the purpose; and finally, economy, which relates to the selection of such a design as to give the best results in first cost, upkeep, and efficiency. To accomplish these ends, there must be provided in the design: (a) a continuous and impervious waterface, consisting of a permanent material; (b) a safe and permanent support for this waterface; (c) that both of the above-named results be obtained with the greatest ultimate economy.

No matter how thin this waterface may be, it will serve the same purpose so long as it remains continuous over the whole area and is imperishable. To maintain it continuous and imperishable, it must be built continuous, must consist of a permanent material that will remain intact regardless of exposure to air, water, or severe weather conditions, and it must have a firm and permanent support. There does not exist in nature a material that will meet all of the conditions of time and exposure to the elements, but permanence must be accepted as a relative term, and time must be considered in finite units; for there does not exist a material that will be left untouched by the tooth of time.

*Consulting Engineer, Hearst Bdg., San Francisco.

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The ultimate destruction of any substance depends on its susceptibility to the attacks of chemical reactions, mechanical abrasions, and the changes in volume due to variations in temperature. Safety, in a finite world, is a finite term, and is relative as applied to freedom from the causes of destruction. There is no such thing as absolute safety, but there can be a close approach to it. A safety that only excepts the cataclysms that would make the works of no further use by reason of the destruction of life from the cataclysms themselves, should meet the conditions.

Safety is attained by knowledge and its application to design, and the execution of design in the erection of works. This knowledge is both theoretical and practical; both are necessary to achieve success. To attain the best degree of safety, there must be used the knowledge of all of the stresses that may be set up by the various conditions of loading that can occur, as well as knowledge of the best method of providing for their distribution and resistance.

There must also be practical knowledge of the natural conditions existing at the site of the works, and all must be given their true weight in the problem. Taking into consideration all of the factors that enter into the problem of the design and erection of the support for the waterface of the dam, each should be given its true weight and a solution obtained for the best ultimate economy. Having safety and permanence provided, the best economy will be the answer sought.

To meet the conditions, the material must be selected that best lends itself to the purpose. As to the waterface film, select the most stable material known: portland cement concrete. For the support for the waterface, we must accept this same material for the same reasons as meeting more fully than any other the conditions of safety and permanence. Having the elements of safety and permanence provided by the use of the most nearly permanent materials known, the next step toward the completion of the solution of the problem lies in the distribution of these materials in such a way as to meet the other condition of ultimate economy.

It is my contention that in all but rare cases, the answer lies in the use of the perfected multiple-arched dam. There is no type of structure for the barrage of water that can be varied in design to meet so many differing conditions, with an equal degree of safety, permanence, and economy. In it are found all of the elements that create safety, permanence, and economy combined. It can be so designed as to give a greater degree of safety and permanence, combined with a greater economy, than can be obtained with any other type. The distribution of the materials used is such that it becomes the true ultimate scientific structure for the purpose of the barrage of water.

That these are not mere unsupported statements, is borne out in the showing that this type of structure will meet all of the requirements for safety, permanence, and economy that experience to date has shown to be necessary. To meet the conditions in a structure placed across a watercourse to resist the loading of a liquid body, is used cement concrete, reinforced with steel where necessary, as the materials best suited for this purpose. With it can be made a waterface that will be impervious, continuous, and permanent; a support for the waterface that will be safe and permanent, and all can be so shaped as to take the stresses set up by the loading efficiently and accom-

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plish these results with the greatest economy.

Herein lies the whole story. A liquid loading is to be carried on the side of a structure, the loading being zero at the top and increasing to the maximum at the bottom. The pressure of the liquid itself is to be used to assist the weight of the structure to give it the required stability. The pressure of a liquid is normal to the surface pressed. The resultant pressure being normal and the resultant of the weight load of the structure being vertical, the resultant of these two will give a final resultant that will lie between the two, and this line should pass through the centre of area of the base of the support to make it the most stable as well as economical. This gives absolute stability and safety against sliding or overturning.

This result, in the multiple-arched dam, is accomplished by making the slopes of the waterface and the downstream edge of the supporting buttresses bear such a relationship to each other that, considering the weight of the structure, the complement of the water load will pass the resultant through the centre of area of the base. The distribution of the stresses equally results in the use of the least material for a given degree of safety, and at the same time gives the lightest possible loading on the foundations. It is a mistaken idea of the service to be rendered by a dam to advocate the use of weight to resist pressure. The aim in the design should be to resist the stresses to which the structure is subjected in such a way as to eliminate any of the causes of the destruction of dams. This is the rational method

REAR VIEW OF THE NEW BIG BEAR VALLEY DAM SHOWING THE BUTTRESSES, STRUT BRACING, AND OUTLET WORKS

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of obtaining the greatest safety.

The causes most in evidence of failure in dams are undercutting of the foundations, sliding, overturning, up-pressure, temperature cracks, and settlement of foundations, all more or less inter-related and progressive, and all destructive. Now it stands to reason that the design is best and safest in which all of the known causes of failure are eliminated in advance of its erection. Having but one face to make tight, this type is easiest to make free from the danger of undercutting. Being balanced in its stability, it is absolutely safe against sliding or overturning. Covering but a small area of the foundations, the water coming through the underlying materials cannot cause up-pressure, for it is always free to escape. Being all in compression, when it is reinforced for temperature change stresses, it cannot crack by shrinkage. The light loading possible on the foundations and the possibility of making the foundation loading as light as desired, makes it safe in this regard. If it is safe from each danger separately, no combination of them can occur to cause danger of any kind whatever.

Making the waterface tight is a problem that must be met, regardless of the type of support for the waterface. This is done in all cases practically in the same manner, by continuing this wall downward until a complete cut-off is made, the difference being that in the case of any other than the structural dam, the water that does pass through is a menace, and the cause of the destruction of most of the solid types that have gone out, while in the case of the structural dam it is practically harmless. This problem calls for practical knowledge or that rare quality called 'good judgment.' That the danger of sliding, overturning, and destruction from either or both of these is brought about by the up-pressure under the structure has been so well established as to require no further proof.

The bane of the solid dam, which relies only on its weight to resist the water-pressure, is the up-pressure of the water that is confined under it, for it reduces its weight and stability against sliding and overturning and by either or both, destroys it. The most notable and disastrous failures of dams in history were those of Austin, Texas, and of Austin, Pennsylvania, both of which were gravity-section masonry dams, and both of which were destroyed by the results of the up-pressure of the water that found its way under them.

The memorable Johnstown flood was caused by the destruction of a filled dam, resulting from a flood overtopping it. The end of the filled dam is overtopping, and this may be caused by its disintegration due to water getting under, through, or over it.

Loose material dams, when considering the fill as a support for the waterface, while rarely menaced by the water flowing through the foundations, if proper attention is given to drainage in their design, are subject to the menace of unusual floods that sooner or later come to nearly every place where water is stored, and unless they are provided with separate spillways of extraordinary capacity, and in addition are given a large freeboard margin, are liable to go out.

There has never been a case where a hollow concrete dam has gone out from any cause whatever. There has been one case (the Pittsfield dam) where one was undermined, owing to the failure to carry the waterface down to impervious material, but it stood as a bridge across the gap, and was re-

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paired by taking the waterface and buttresses down to firm foundation, and it is now as good as ever and still in service.

This partial failure of the Pittsfield dam has done more to strengthen the faith of engineers in the hollow type of dam than the continued service of all of the others that have had no mishaps, and was the best test the hollow dam ever had. The multiple-arched dam has all the elements of strength and safety of the most liberal sections of solid dams; have the danger of uppressure eliminated; have an evenly-distributed loading; have a higher safety factor; and can be erected at less than half of the cost in half of the time. The multiple-arched dam has none of the faults of the loose material dam, being in itself a spillway.

The distinct advance of the multiple-arched dam over the deck types of hollow dams lies in the use of the arch instead of the flat deck, eliminating tension from the structure, which again gives it greater flexibility as to design, permitting its adaptation to any site for any height. It also permits the use of less material for a given strength —this again finally making it the cheapest permanent structure possible.

Concrete is noted for its lasting qualities, for the ease with which it can be molded to any shape, and its ability to resist compression. It is therefore the best material that is known to man for the erection of structures that rely on the durability and strength of a material in compression for their service.

The multiple-arched dam is built entirely in compression, and concrete is therefore the logical material for its construction. The oldest structures in use on earth today are of concrete. The shapes of structures that have withstood the ravages of time are the arch and the pyramid. The arched bridges built across the Tiber by the Romans before the Christian era are still in use, the Pyramids of Egypt are as they were in the days of the Pharaohs. The multiple-arched dam is built of the same materials, is made up of arches and pyramids, and the whole structure is in itself a pyramid, and will stand with the pyramids as a type of the most permanent, safe, and scientific structures erected by mankind.

Y. M. C. A. Building, San Diego

By E. F. CYKLER*

THE San Diego Y. M. C. A. building, recently completed, furnishes a good example of the substantial type of buildings used by this Association. The building is 'L' shaped and covers a large area, having 200-ft. frontage on Eighth street and 50-ft. frontage on C street. The gymnasium is 100 ft. deep and 50 ft. wide, and the main structure outside of the gymnasium is 150 by 50 ft., five stories in height. It is a class 'A' building, of reinforced concrete construction throughout, with 8-in. hollow terra

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cotta curtain walls, carried at each floor on concrete spandrel beams, as shown in Fig. 1. This photograph shows the form-work in place on the fourth and fifth floors, and terra cotta curtain walls are still to be set in between the skeleton concrete frame.

Typical Framing.—In order to get a flat ceiling, and due to the long spans, the opening was left out and a header beam of the depth of the slab and of the required width was thus formed, and which was reinforced with double the reinforcing of the ordinary slab beam. All these slab beams were spaced on the plans in order to facilitate detailing and placing on the job. For the 16-ft. spans 6-in. tile and 3-in. concrete,

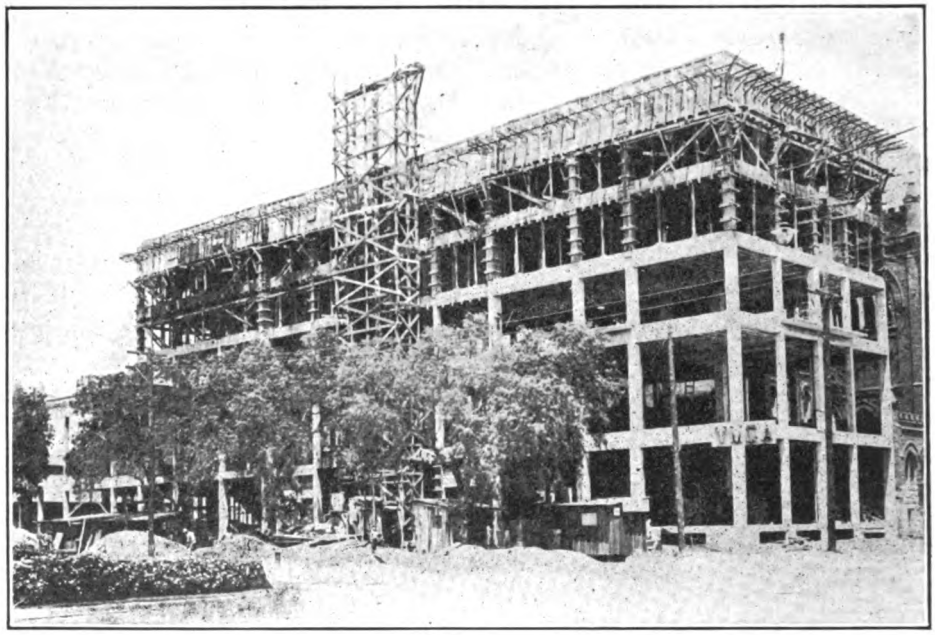

FIG. 1. SAN DIEGO Y. M. C. A. BUILDING, SHOW ING FOURTH AND FIFTH FLOOR FORMS IN PLACE.

terra cotta tile set in between concrete beams was used in the floor-slab construction. The concrete beams have a width of 4 in., and are reinforced by two corrugated square bars, one bar bending up at the quarter point of the span at 30° and running through to the quarter point of the adjacent span, so that the beams were continuous over supports. These beam bars were made up in units and wrapped with No. 5 wire to form stirrups. The tile is 12 in. wide, making the concrete beams 16 in. centre to centre. At openings through the slab, the tile adjacent to reinforced with two ⅝-in. bars, were used, giving a total thickness of 9 in. for the slab, while on the 22-ft. span in the gymnasium 8-in. tile and 3-in. concrete were used with two ¾-in. square bars for reinforcing, making a total of 11 in. for depth of slab.

The typical carrying girders contained in most cases five reinforcing bars, three of which were placed in the bottom and the remaining two were placed between the three bottom bars and with an inch space between top and bottom layers of bars. The upper two bars were bent up at an angle at

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45° at quarter point and run through to the quarter point of the adjacent span. In addition to this, one bar was bent up from the bottom layer at an angle of 45° and run only to the column centre line. In all cases it was figured to get at least 75% of reinforcing over supports. The depth of the forms held the main reinforcing up the proper distance from the bottom of the forms, namely, 1½ in. to bottom of steel.

The columns were figured for 600 lb. per square inch on the concrete for the inner core with the vertical reinforcement banded with No. 3 wire, 8-in. centres. Dowels were used at column splices of sufficient length to give a lap of 30 diameters. One and one-half inches of fireproofing was specified around all reinforcing steel. The foundations were built on a good hardpan, and a maximum of four tons per square foot soil-pressure was used for total dead and live loads, although the footings were all proportioned to have the

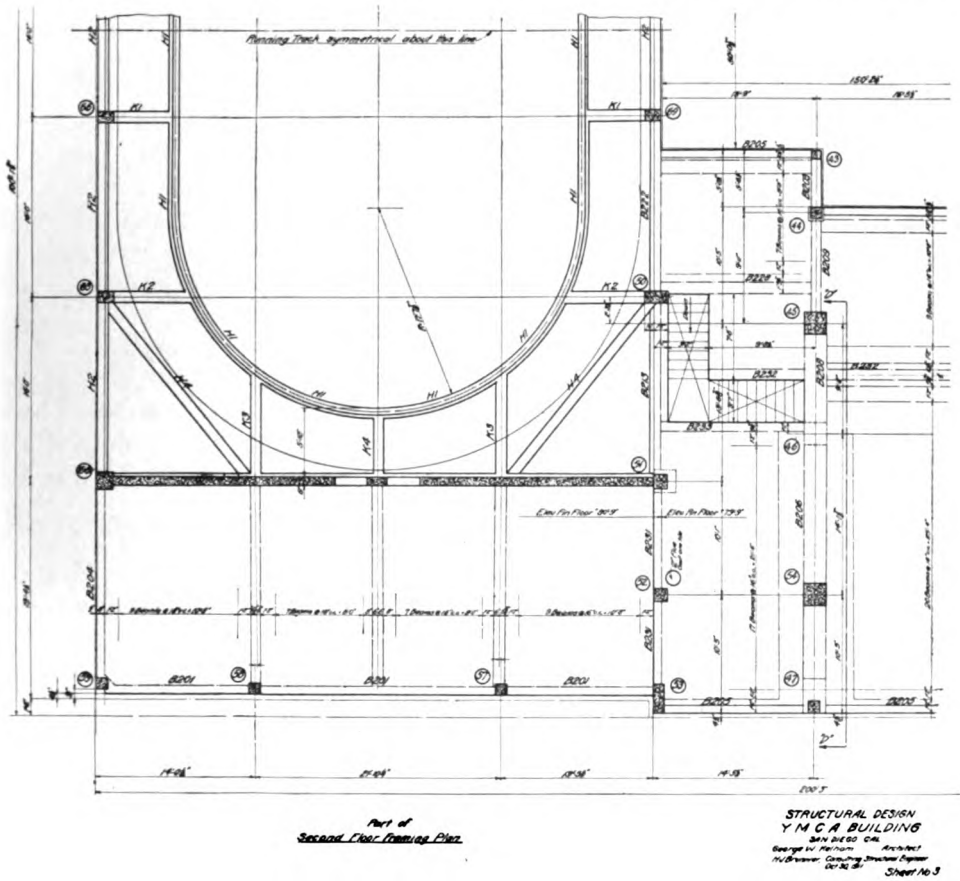

FIG. 2. PLAN OF RUNNING TRACK.

the T of the girders in all cases was the total thickness of the slab, namely, 9 in. or 11 in., as the case might be. Additional vertical ⅜-in. or No. 0 wire stirrups were used so that the shear on the concrete would not exceed 50 lb. per square inch. The diagonal reinforcing bars were neglected in figuring for shear. These stirrups were bent in such shape that the ends resting on

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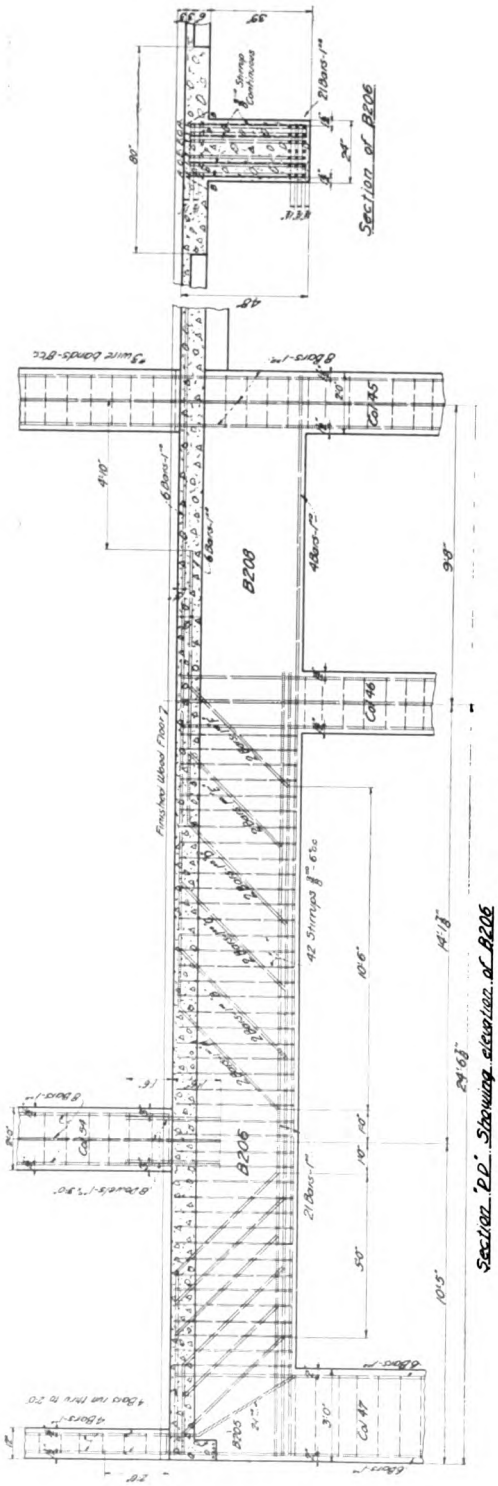

FIG. 3. ELEVATION OF GIRDER No. 206.

same intensity of pressure for dead loads only.

Special Framing.—Fig. 2 shows the plan of the running track, and section *D-D*, Fig. 3, shows the elevation of girders No. 206 and 208. Girder No. 206, in the second floor, carries a concentrated load of 230,000 lb. from column No. 54 in addition to the floor load of the second floor. The bending moment was calculated at 0.1 W/L in that it framed into a 3-ft. column and was made continuous over column No. 246 through beam No. 208 (see Fig. 2). The shear on this girder was high, and two-thirds of it was taken up by the bent-up main diagonal bars and one-third taken up in ⅜-in. square stirrups spaced as shown, leaving no shearing stresses theoretically on the concrete. This girder contained twenty-one 1-in. square bars and was 24 in. wide by 48 in deep with a T 80 in. wide and 9 in. deep. The depth of 48 in. was prescribed by the architect. Special care was taken in pouring this girder, as discussed later under specifications. Note that column No. 54 takes the reaction of girder No. 301 (Fig. 5) in the third floor, which is over the assembly room in the second floor and is free of columns.

Fig. 2 shows the 8-in. wall girder between columns 51 and 60, also shown at the far end of Fig. 4 with the opening through it. This wall girder extended 2 ft. 9 in. below the finish floor and 18 ft. above the handball court floor, making a total depth of 20 ft. 9 in. which was poured as a whole. It was reinforced with ten 1-in. square bars, six of which were bent up in pairs at an angle of 45° and run over to the columns. The running-track cantilevers out of the lower end of the girder on one side, and the handball court is at the opposite side, thus requiring this girder in order that no

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columns would run through the court wall, as a plane surface was necessary. In addition to the main reinforcing, ⅜-in. square horizontal bars 12-in. staggered centres, and ⅜-in. vertical bars 12-in. staggered centres were used, also two columns were formed in the 8-in. wall with four ¾-in. bars on the centre line of columns 58 and 57 in order to add stiffness at points of framing, both at the roof and at the running track.

Fig. 4 is a photograph of the running track illustrating the circular girder at the ends of the cantilevers, shown in detail in Fig. 7, also the arches in the roof construction. Note the pleasing effect given by this framing and how well the gymnasium floor is lighted from the skylights above. No terra cotta had been set into the walls at the time this photograph was taken. The detail of the cantilever beams K-1 and K-2, shown in Fig. 7, is typical for all the running-track cantilevers with the exception of variation in depth and length due to the curvature of the track. This track was figured for a

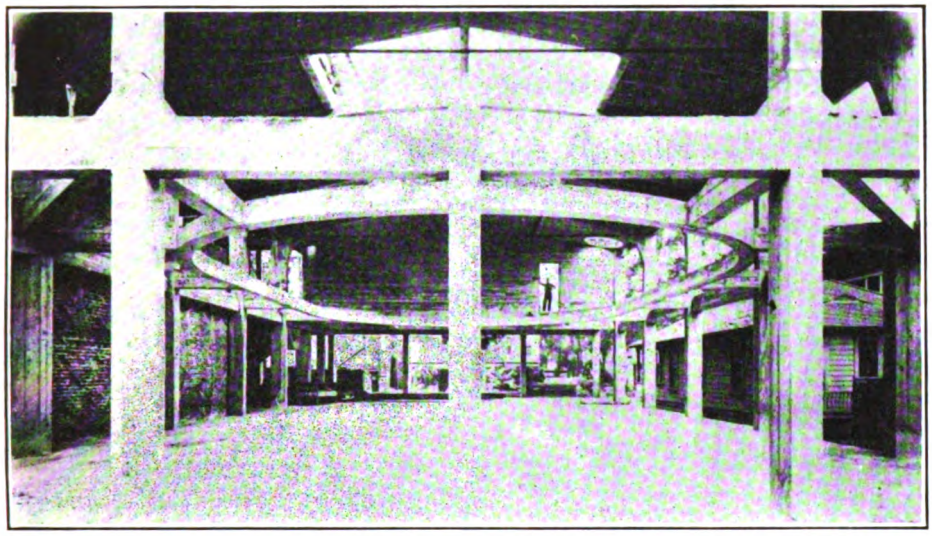

FIG. 4. INTERIOR VIEW SHOWING RUNNING TRACK SUPPORTING STRUCTURE.

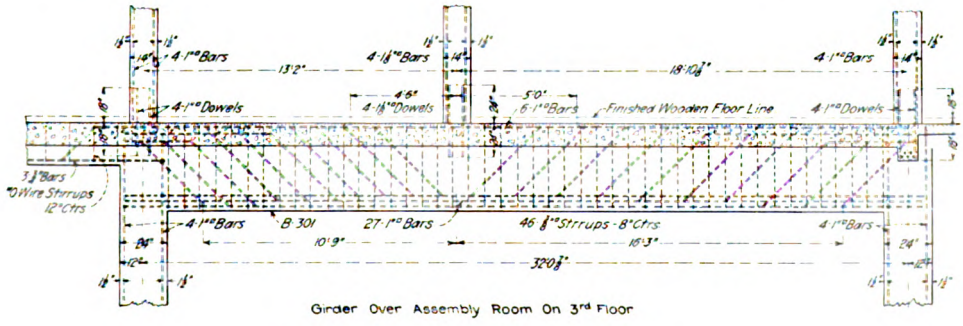

FIG. 5. ELEVATION OF GIRDER NO. 201.

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live load of 75 lb. in addition to the dead load. The columns were reinforced to take the bending induced by these cantilevers. Three ⅞-in. bars were bent in U shape and four more were placed straight in the top with a hook into the column (see detail). These four bars were placed in straight, as it was not considered that they would work properly if bent to conform to the upper outline of the cantilever, for the reason that the heavy stress would then tend to straighten them out before they would come into action. Beams H-1 and B-2 were notched, as shown, to take the wooden joists to support the running track. With the running track thus supported, a fine open gymnasium resulted, as shown in section through the gymnasium (Fig. 6). Under the gymnasium floor are the swimming pool and locker-rooms and a spectator's gallery. The swimming pool is a standard tank, 20 ft. wide by 60 ft. long, with a depth of 2 ft. 6 in. at one end and 5 ft. at the other end, the greatest depth of 8 ft. occurring 18 ft. from the deeper end. It is lined with 1½-in. tile, the bottom having a cement finish. The arch shown in Fig. 7 is 12 in. wide and spaced 16 ft. centres. The roof over the gymnasium is a 5-in. slab reinforced by No. 3 and No. 8 Clinton fabric, 2 by 12-in. mesh, running from arch to arch. The centre portion is open and

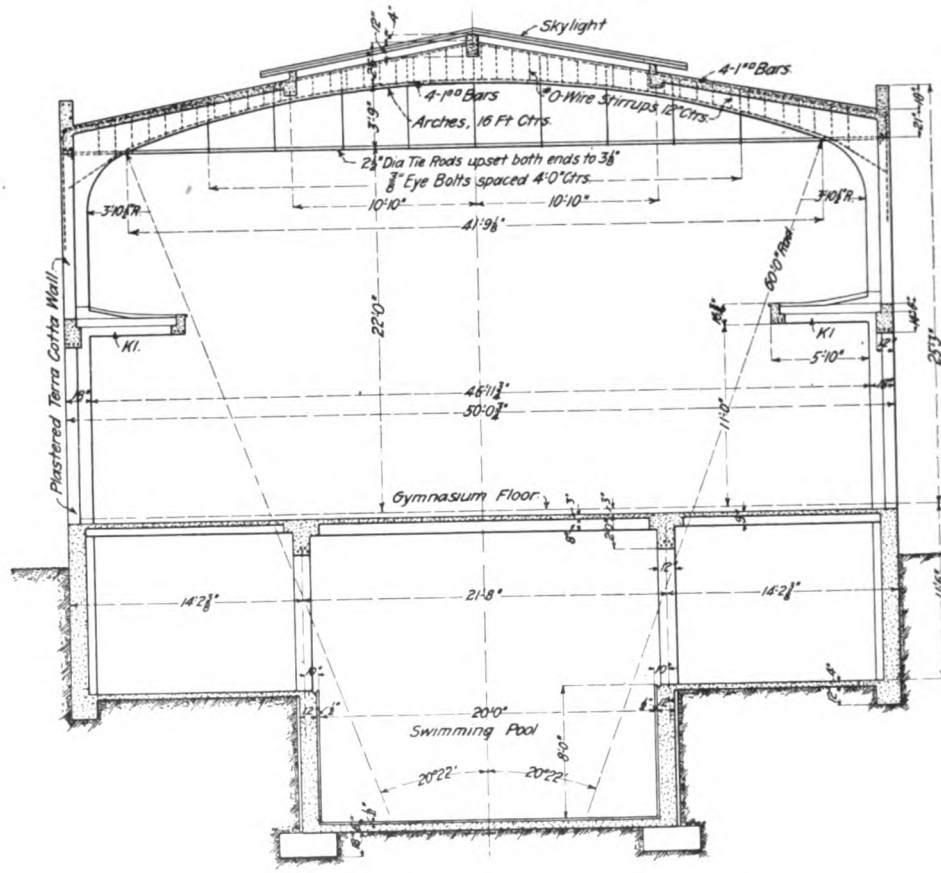

FIG. 6. SECTION THROUGH GYMNASIUM AND SWIMMING POOL.

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occupied by skylights. The maximum horizontal thrust was 53,600 lb. and was taken care of by a 2½-in. tie-rod with ends upset to 3⅛-in. diameter, and a 12 by 12 by 1-in. bearing plate with a 5 by 5 by 4-in. thick nut on each end. This tie-rod is held in position by a series of ⅜-in. eyebolts and the gymnasium apparatus is also hung from it. The arches were figured from a range in temperature of 60°F. from the lowest to the highest, and a live load of 30 lb. per square foot. It was figured as rigidly supported with fixed ends.

Beam No. 301, in the third floor, supporting columns 55 and 56, as in Fig. 5, occurs over the assembly-room as referred to under beam No. 206. The reaction of B-301 is carried through column 54 as a concentration to B-206 in the second floor, thereby making a complicated piece of framing; columns 55 and 56 support the fourth and fifth floors and roof and have a load of 108,500 lb. at the third floor. Besides this concentration, B-301 supports a uniform load of 112,500 lb. It was figured as simply supported, and the shear was taken care of in a manner similar to B-206, by means of diagonal main reinforcing bars and by stirrups. The depth of these beams was made the minimum possible, so as not to come down too far in the assembly-room. Six additional 1-in. square bars were used in the top for compression as shown. All stairs throughout this building are of concrete and similar to the detail shown in Fig. 8, having a 2-in. concrete balustrade which is reinforced by ¼-in. bars, and the main stair slab 4½-in. deep, reinforced by ⅜-in. bars as called for in the detail. These stairs are very rigid, as is the 2-in. balustrade, and give a pleasing appearance. Small wood blocks are set in the 2-in. balustrate when being poured, to which is fastened the wood hand-rail. All stairs and balustrades were finished with a ½-in. cement coat.

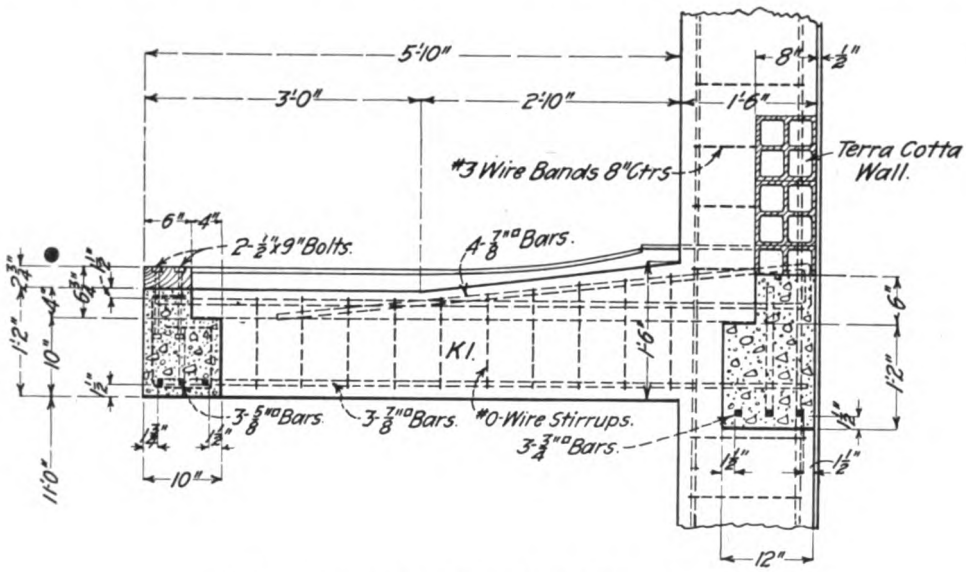

FIG. 7. DETAIL OF CANTILEVER RUNNING TRACK BEAMS.

All work was done by day labor, and all cement used on this work was tested before going on the job and had to conform to latest standard specifica-

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tions of the American Society for Testing Materials. Concrete was mixed in proportion of one part cement, two parts of sand or fine aggregate, and four parts crushed rock or coarse aggregate. Special features called for in the specifications are as follows:

(1) All walls must be built up to same level all around the building. No

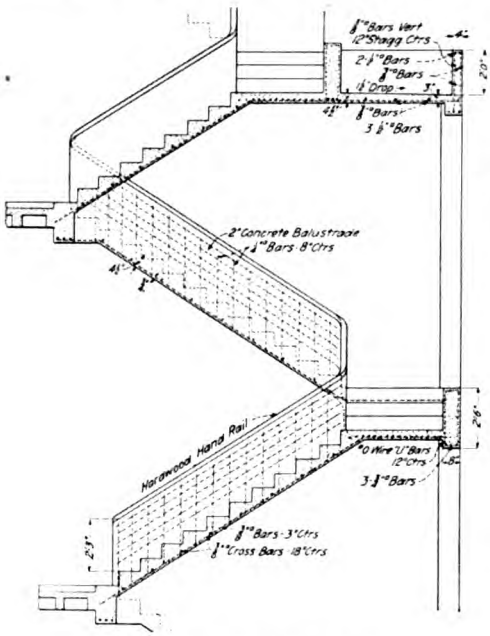

FIG. 8. DETAIL OF STAIRS.

pyramiding of concrete will be allowed. (2) Pour all columns up to bottom of beams and girders and allow to stand for an hour before pouring beams, girders, or slabs. (3) Girders and beams of T section over 24 in. deep must be poured to bottom of slab or T, allowed to stand for three-quarters of an hour and not over one and one-half hours before pouring balance. Should be tamped thoroughly. This last clause assures that the slab or T will not crack away from the stem of the beam due to contraction or settling of the forms and thereby destroying the carrying capacity of the beam by having the compression portion of the beam ruptured from the stem. This was absolutely necessary in the large girders No. 206 and 301 in this design. No deflection occurred from the removal of the shoring under these girders, and no indication of cracks has appeared to date. On tests made of tamping concrete for our own satisfaction, we found that in cylinders taken from the mixer and allowed to stand for half an hour and then tamped, the compressive strength was increased to almost double, but if tamped after three hours from the time of pouring, it weakened the concrete materially, due to breaking up the concrete that had just set. Sample cylinders 6-in. diameter, taken and tested from time to time, developed in the neighborhood of 2000 lb. per square inch at the end of 28 days. The building is now open to the public. George W. Kelham, of San Francisco, is the architect.

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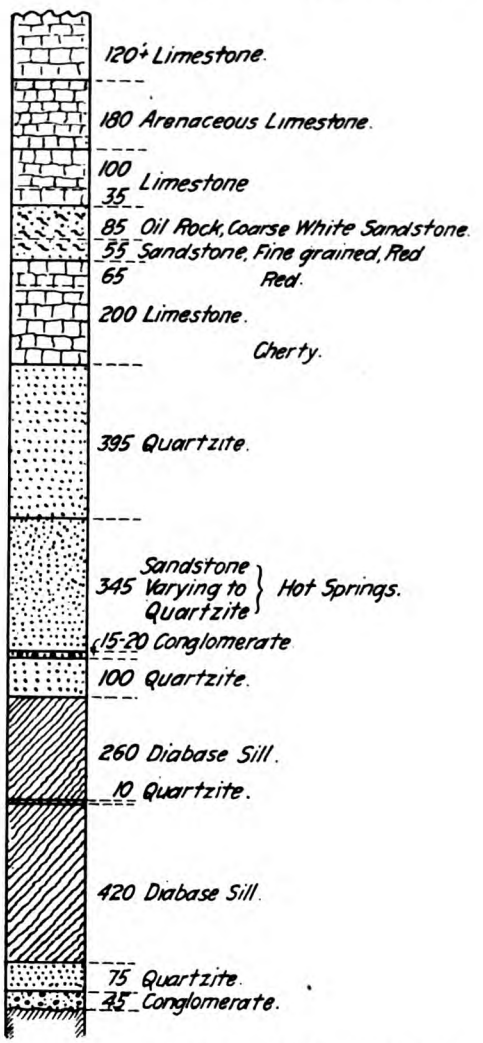
A Possible Arizona Oilfield

By C. A. BOTSFORD

ABOUT ten years ago considerable interest and excitement was aroused by the announcement that oil-bearing sandstone had been discovered in the lower Tonto basin, near the confluence of Salt and Tonto rivers, in Arizona. At that time many claims were located, and doubtless steps would have been taken to develop the field, had it not been for the fact that to do so would interfere with the plans of the U. S. Reclamation Service. The plans for the Roosevelt reservoir were in course of preparation and the federal authorities withdrew from entry every township that would be touched at any point by the reservoir. Afterward when the project was completed the unused portions of these townships were restored to the public domain. In consequence of this restoration a company has been organized to acquire and develop a property in this field. This corporation, known as the Tonto Basin Oil Co., is officered by men of many years experience in the oil and gas-fields of Pennsylvania and Kansas.

The property, consisting of 33 claims containing 3080 acres, is situated at the lower end of the Tonto basin near the town of Roosevelt, in Gila county. The geologic structure of the country for several miles to the northeast of the lower Tonto basin, is broadly monoclinal, pitching gently to the southwest. The rocks are chiefly quartzite, limestone, and sandstone. The topography is rugged and the slopes precipitous. This is due, not to great deformation, but to the rapid erosion that has been and is still going on. Most of the



GENERALIZED COLUMNAR SECTION, TONTO BASIN OIL DISTRICT.

streams flow in a southerly direction and have cut deeply into the sedi-

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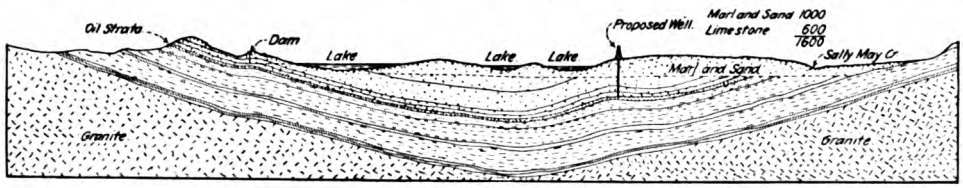
mentary formation, revealing a structure of unusual regularity undisturbed by any great regional upheaval.

To the southwest of the Tonto basin, this structure is interrupted by the Mazatzal mountain range. This range, extending from the northwest to the southeast, is composed of granitic and schistose rocks, flanked on the northeast by the sedimentary rocks. These mountains were formed by a great granitic intrusion that uplifted the then flat-lying sedimentaries and bulged them into a roughly dome-shaped structure. The top of this dome has since been removed by erosion, and today the sedimentary series can be seen only on the flat-lying foothills of these mountains. In the Tonto basin these dip to the northeast and gradually flatten toward the valley. The tilting of the strata by this intrusion has resulted here in the formation of a broad synclinal fold. In the southwestern limb of the fold where the beds are exposed, the uniformity in the change of dip is interrupted in places by flattening and by local domes and anticlines. These irregularities in the broad syncline are a result of unequal pressure at the time of folding and probably occur at intervals throughout the unexposed portion of the fold.

It is well known that interruptions of this nature, that is, local flattenings of the dip, domes, or anticlines, afford ideal conditions for the retention of pools of petroleum where other conditions are favorable.

The tilting and bending of the strata with subsequent erosion has exposed the croppings of the sedimentary series on the foothills of the Mazatzal range. In this series is found the coarse, porous white sandstone represented in the geological section as 'oil rock.' This sandstone is 85 ft. thick and varies in texture from a medium to a coarse grain. It grades without any sharp line of demarcation into a reddish fine grained strata about 35 ft. thick, which is underlain by a dense limestone. Directly over the 'oil rock' is a gray limestone; the lower portion of which is fine grained and impervious and is called by oil operators the 'cap rock.' This rock when freshly broken or rubbed briskly with a hard substance gives off a strong odor of petroleum. Portions of the oil rock have been found to contain globules of paraffine, and same samples have yielded, by distillation, as high as 10% of high-grade paraffine oil.



SECTION ON LINE N.37°E., TONTO BASIN OIL DISTRICT.

A large part of the Tonto basin is covered with a thick bed of comparatively recent origin. This varies from an earthy marl interlain with thin beds of gypsum to a coarse loosely cemented sandstone. These sediments were laid down in an ancient lake, formed by the damming up of the waters from the north by the Mazatzal upheaval, which formed a lake of large expanse. It was eventually drained by the cutting through of the barrier by erosion and the scouring out of the gorge of what is now the Salt river channel below the site of the Roosevelt dam.

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In summarizing as to the probability of finding oil in paying quantities in this field, the following facts are important: (1) The property is underlain by a thick promising bed of oil-bearing sandstone; (2) samples of this rock yield by distillation a high-grade paraffine oil; (3) the geologic structure is unbroken and favorable for the formation of oil pools.

Use and Conservation of the Underground Reservoirs of California

By CHARLES H. LEE*

THE underground water reservoirs of California are among the most valuable natural resources of the state. Their existence is generally unknown, however, and even the irrigator, who depends largely upon underground sources for his water-supply, has a hazy idea of the physical conditions governing that supply. The uses of underground water in California are important and varied, including industrial and municipal consumption and irrigation. The total development of groundwater in the state by pumping and artesian flow was stated by W. C. Mendenhall, in the 1909 report of the National Conservation Commission, to be more than 1000 second-feet, which amount is now considerably exceeded. It is safe to say that in the southern part of the state the most valuable natural resource is the yield of the underground water reservoirs, and their growing importance in central and northern California is shown by the prominence given them in connection with the future municipal water-supply of the San Francisco Bay region.

As is the case with other natural resources, there is in each district a limit to the supply of available underground water, notwithstanding the statements of enthusiastic real estate operators to the contrary. The immediate result of overdraft upon an underground reservoir is the permanent reduction of artesian pressure or general lowering of the groundwater surface. The ultimate effect of overdraft is to lower the water plane to such a depth that the cost of raising the water to the surface exceeds the revenue derived from its use or the ability of the consumer to pay. Such a condition involves not only loss of revenue from capital invested in water-development property, and in all probability the capital itself, but also brings great hardship and possibly ruin upon the dependent community.

The general lack of knowledge regarding underground water conditions is well illustrated by the reliance which even managers of some large financial interests place in the 'water witch' with his forked willow stick. I have known of cases where, at the advice of one of these men, thousands of dollars have been spent for water development in localities where a short investigation along scientific lines would have

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shown the folly of such effort. An experienced well-driller, after long familiarity with a region, often develops very good judgment in locating wells in his district, but his value is local and in no case depends on a mysterious sixth sense.

The development of scientific knowledge and principles pertaining to the subject of underground waters has been very recent in the history of modern engineering progress, and is still in process of growth. During the last fifteen years, the increasing importance of this source of supply has led to the gathering of data and study of local conditions, most of which work has been done by the United States Geological Survey. There has now been sufficient progress made to establish the broad principles governing the occurrence and movement of underground water from its source to its final destination, and to ascertain with reasonable accuracy the most desirable locations for its development and the extent of the permanent supply of a given locality. The practical application of such knowledge is opening a new field of endeavor for the hydraulic engineer with technical training supplemented by detailed practical experience along these lines. A brief description of the underground water reservoirs of the state, and their proper use, should be of interest not only to investors and the general public, but also to the engineering profession.

Subterranean Storage Reservoirs.—The important underground water supplies of California are derived from what may be termed underground water-storage reservoirs. These subterranean reservoirs consist of the void spaces surrounding particles of gravel and sand filling the closed structural basins represented by topographic valleys. Typical among such reservoirs are San Bernardino and San Fernando valleys in southern California, and Santa Clara and Livermore valleys in central California. In some instances, as in the San Bernardino valley, a clay capping extends over the lower portion of the valley, confining and retarding the movement of the water in the gravels beneath. The confined waters, being under a considerable hydrostatic head from the water at higher levels around the rim of the basin, exhibit artesian pressure, and will flow out to the surface where the clay capping is punctured. Other valleys, such as San Fernando, which do not exhibit important artesian phenomena, are merely deep basins filled with porous gravel and sand.

The underground reservoirs of California and the arid West are a unique feature of the region, being unknown in the Eastern states. They are largely the result of crustal movements, such as faulting, which have involved the relative depression and elevation of large adjacent areas, with accompanying readjustment of drainage systems. High-grade, débris-laden, and torrential streams have thus developed, discharging abruptly from narrow canyons into wide low-grade valleys. These crustal movements are slow, and the accumulations of erosional débris increase as the depression becomes greater and greater. Most of these basins are of considerable depth. Wells in the San Bernardino valley do not reach bedrock at a depth of over 1000 ft., and it is stated by J. C. Branner, after careful geological study of the situation, that the vertical displacement along the west edge of the Livermore valley is at least 3000 feet.

A further necessary feature of a closed basin is an impervious floor and rim. Such are provided by the characteristic granite rock of the interior

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portions of southern California and the sedimentary rocks of the Coast Range. The subterranean outlet of these reservoirs is usually a narrow gravel-filled gorge cut through the rock rim at the point of lowest depression. Many basins have no underground outlet, and in no case does the underflow through such a channel represent a large percentage of the natural outflow from the reservoir.

Supply and Yield.—The general features of supply and yield of an underground water reservoir correspond with those for surface reservoirs. The principal difference lies in the relative speeds with which the general water surface assumes a horizontal position following change in volume. In the case of a surface reservoir or lake, the effect of inflow and outflow is an immediate complete adjustment of surface level. The frictional resistance offered by the particles filling an underground reservoir is so great, however, that the movement of water from an area of high level is very slow, varying from a few hundred feet to a few feet per day, depending on local conditions. As a result, the water surface in an underground reservoir is never horizontal, being steepest near the source of supply, most nearly horizontal at the region of outlet, and varying in slope and elevation from time to time, depending on the rate of recharge.

The sources of supply of underground reservoirs are percolation from flowing surface streams, from precipitation, or from irrigation upon the surface of the porous gravels. The water thus absorbed sinks downward to the general groundwater plane, and then moves laterally toward the region of lowest depression. This region is usually characterized by springy, swampy conditions, and is commonly known in southern California as a *cienaga*. The natural outlets for underground water are by springs or seepages discharging into the surface channels which drain the *cienaga*, by evaporation from damp soils and vegetation within the *cienaga*, and to a limited extent by underflow from the basin. The surface streams formed by the oozing out of underground water join to form a larger stream, which in all respects corresponds to the outlet of a lake or reservoir, and passing from the basin pursues its course just as any other surface stream. Its flow is characterized by great regularity and permanence.

The outlet by evaporation, although seldom considered, is yet the avenue by which a large proportion of the underground supply escapes. It has been determined for the Independence basin in Owens valley, by careful measurements extending over a period of several years, that 90% of the total volume of water which percolates into the gravels of the basin finds its outlet by evaporation into the atmosphere. The average annual depth of water lost in this basin from an area of 55 square miles of damp, alkali-crusted soil and meadow land was 2 ft., and from portions of the area exceeded 5 ft. Estimates of evaporation from the wet lands in Livermore valley place the amount lost at nearly 50% of the water absorbed by the basin. The importance of soil evaporation and transpiration in connection with underground water investigations is therefore apparent.

The average annual rate of recharge of an underground reservoir by percolation must obviously equal the aggregate of outflow by springs, seepages, evaporation, and underflow. Otherwise, persistent lowering or rising of the water plane would occur until a balance was reached. Artificial draft consists in withdrawing water from the

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porous gravels by pumping or artesian flow. Water thus extracted which does not return to the gravels by percolation reduces correspondingly the volume of water passing from the basin by way of natural channels. The limit to the average volume of water which can be withdrawn by artificial methods from an underground water reservoir is the rate of natural recharge less unavoidable loss by natural channels, such as transpiration, soil evaporation, and underflow.

The determination of the probable yield of commercial water from an underground reservoir of the closed-basin type has been formerly passed over as a problem too difficult for solution with reasonable accuracy. The results obtained in the Independence basin of Owens valley in connection with the development of an auxiliary groundwater supply for the Los Angeles aqueduct indicate, however, that the problem can be solved and a result obtained commensurate in accuracy with ordinary commercial requirements and at a reasonable cost. The results of the extended series of measurements made under my direction in that basin show an agreement to within 10% of inflow and outflow from the gravels filling the closed basin.

The problem for a complete solution and a check requires measurement of both inflow and outflow, as was done in Owens valley. Where a study of the geology indicates with reasonable certainty that the basin is closed, a determination of outflow is sufficient, and since in most cases where underflow occurs it is very small in amount, the latter method has wide application. The necessary field observations for complete solution consist of the measurement of stream percolation losses for various rates of flow, precipitation upon the surface of the gravels, extent of irrigation, duty of water, and percolation from precipitation and irrigation. These should be supplemented by measurements of flow of springs and seepage return water leaving the basin by surface channels, of soil evaporation for varying depths to groundwater, of depths to groundwater, of the fluctuation of groundwater surface, and of the area of evaporating surface for various depths of groundwater. The problem as presented for practical solution has many variations and simplifications, depending on the local conditions, but the general solution is along the lines described.

Conservation.—As stated before, the limit to the average volume of water which can be withdrawn by artificial methods from an underground water reservoir is the rate of natural recharge less waste and unavoidable loss by natural channels, such as transpiration, soil evaporation, and underflow. The possible methods of increasing the yield of commercial underground water from a basin, therefore, are by artificially increasing the rate of recharge, by elimination of waste, and by maximum reduction of unavoidable loss. The amount of water developed from many of the large basins of southern California is so dangerously near the limit that efforts are already being made to conserve the supply.

The most obvious method of increasing the rate of recharge is by accomplishing a greater absorption of stream flow than occurs naturally. The spreading of winter flood waters of Santa Ana river and other streams upon the waste gravel lands adjoining the stream channel is proving very beneficial in this respect. When properly planned and carried out, such a system provides cheap over-year storage far more efficiently than surface reservoirs because of the elimination of evaporation losses

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during storage. The periodic occurrence of extremely dry years in southern California makes the over-year feature of storage very desirable.

The question of a just distribution of the cost of water-spreading work is one that presents great difficulty. The benefits are enjoyed by all users of water from the common reservoir, yet very few realize the value and importance of the work, and, hence, cooperation is extremely difficult. The obvious solution is for the local community or the Government to carry on such work. It involves the reservation of suitable lands upon which to spread the water, the construction of necessary diversion and control works, and the maintenance of an organization to carry on the work. The rapid increase in the use of underground water will make water-spreading a universal necessity in southern California.

The principal source of avoidable waste from subterranean reservoirs is by failure to cap flowing artesian wells when not in use. This valuable natural resource is thus being recklessly dissipated in many basins of the state, notwithstanding the fact that laws are on the statute books providing for the capping of artesian wells during non-use. The installation of adequate control is simply and cheaply accomplished and there is no reason why public sentiment in each community should not compel public officers to enforce the law.

The possibility of reduction of so-called unavoidable losses, consisting largely of transpiration and soil evaporation, has been given very little attention in the past. A large proportion of the outflow from both closed and partly closed basins is of this character, however, and I have given the subject considerable study. The losses from swamp areas supporting luxuriant fresh-water vegetation far exceed those from a lake surface of equal area, and when it is realized that there are a number of square miles of swamp exposure in such basins as San Bernardino and Livermore valleys, the amount of water involved can be appreciated. The general method of attacking the problem is by lowering the local groundwater surface below the limits of capillary action in the soil. This can be done in several ways, and to a limited extent has been unwittingly accomplished in at least two of the southern California basins. There are great possibilities for groundwater conservation along the line thus suggested. The problem is a broad one, however, involving not only complicated engineering features, but also financial and legal difficulties.

The complicated physical feature of the problem lies in the fact that many of the large *cienagas* are underlain by water under artesian pressure. The relief of this pressure by drilling numerous deep artesian wells, although very effective in reducing the area of swamp land, is yet injurious to the interests of the owner of existing shallower artesian wells, and of pumped wells around the rim of the artesian area. The immediate result of opening many deep wells is a reduction or complete cessation of flow from shallower artesian wells, and a marked lowering of water-level in pumped wells around the rim of the basin. The situation corresponds to that in a large diameter pipe-line filled with water under a static head, when a small valve is opened at the lower end. The attempt to increase the yield of useful water from an underground reservoir by this method is therefore undesirable in all cases where the whole basin cannot be controlled by a single owner.

Shallow pumping within the swamp area is probably the solution of the problem which will be adopted ulti-

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mately. A pumping system properly designed could accomplish and maintain complete drainage of the first 10 ft. of soil, thus eliminating evaporation loss, rendering the land fit for cultivation, and at the same time developing a water supply. The cost of water developed from such a system, although not as cheap as an artesian supply, would yet be far less than that of water developed for irrigation by pumping from wells of moderate depth, of which there are so many successful examples in southern California.

The growing popularity of underground water supplies in California, and the present complete use of surface waters in portions of the state are indicative of the fact that future extension of irrigation will come about through conservation and complete use of the yield of the underground reservoirs. The time has arrived, therefore, for wide knowledge of the physical occurrence and governing principles of this natural resource in order that it may be dealt with wisely for the benefit of the people.

Concrete as a Paving Material

By W. C. HAMMATT *

IN the many criticisms of the specifications for pavements used by the California State Highway Commission and others, it seems to me that the main point has been neglected. Most of the critics assume that the concrete base is proper, and that the cause of failure in this class of pavement, namely, a thin asphaltic wearing surface on a concrete base, is the thinness of the wearing surface. This attitude is not peculiar to this locality, it being taken for granted generally throughout this country that concrete is the proper material for the base, all discussion centring on the nature of the wearing surface.

From my first experience with paving work, some twenty years ago in Chicago, there has been some doubt in my mind regarding the efficacy of concrete as a paving material, and this doubt has grown with continued study and observation until the objections thereto are now clearly defined in my mind.

While concrete is an excellent material for some classes of building construction, it has its limitations. Its chief defect lies in its high coefficient of expansion, in the great shrinkage in setting, and in its lack of elasticity. This makes it a bad material for use under conditions of varying temperature where the design of the structure is not such as to allow the travel required by conditions of expansion and contraction. It is possible to make this provision in building construction, bridge construction, and others where the structure may be so designed as to permit the movement of each unit to take care of its expansion and contraction, and where steel reinforcement is introduced, which, having practically the same coefficient of expansion as the concrete, and having the necessary tensile strength to take up the stresses

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introduced by the temperature changes, prevents the breaking of the concrete. It is also possible in subterranean and subaqueous foundations, where the changes in temperature are not sufficient to rupture the concrete.

Concrete is especially ill adapted to construction in extensive, comparatively thin sheets, laid on the earth, or on any continuous support. Concrete floors and sidewalks, if not marked off in blocks, invariably show cracks after construction. When marked off in blocks, the concrete is generally weakened at the groove, and the cracks occur on these lines, at which they are not apparent. In the case of concrete curbs and gutters, unless they are marked off into lengths of 8 or 10 ft., they promptly become traversed by cracks at intervals of a few feet.

When an asphaltic wearing surface is laid on a concrete base, the base promptly breaks into blocks beneath the asphalt. If the wearing surface is thick enough and the traffic is heavy enough, the asphalt is 'ironed out' by the wheels and does not itself crack, although the position of the cracks in the concrete base may be found by an inspection of the asphalt, which has a glazed appearance over the crack. If the traffic is light, however, or the wearing surface is less than 2 inches thick, the crack in the concrete appears also in the asphalt, due to the adhesion between the asphalt and its concrete base.

The same action takes place when paving blocks or brick are laid directly on a concrete base and grouted or asphalted at the joints, thus forming an intimate contact. The joints between the blocks widen and show stepped cracks following approximately the zigzag cracks in the concrete foundation. This does not occur, however, when the block pavement is laid with a sand cushion between it and the concrete, as the movement of the concrete is then not communicated to the wearing surface.

Recent articles have been published in the technical press describing concrete roads built in various places. I note that one described in Kansas has expansion joints at frequent intervals, or, rather, contraction joints, as they are formed by placing tarred paper between portions of the work, thus forming transverse joints across the pavements, destroying the continuity of the concrete and eliminating large tension stresses. While this method will prevent the formation of irregular cracks, it also destroys the water-tightness of the road surface.

The fourth report of the Illinois Highway Commission is complete in its treatment of different classes of pavement. It devotes some space to concrete pavements, and also discusses the expansion joint. In this matter it advises running the joints diagonally across the roadway and armoring the edges with steel plates or angles. While these expedients will lessen or prevent the cracking of the pavement, and will also prevent the raveling and spalling of the concrete at the expansion joints, there is still a leaky pavement.

Pavements have been compared to houses, in that the main requirements are a substantial foundation, a superstructure suitable for its occupancy, and a water-tight roof. While concrete may make a 'substantial foundation', even when cracked either naturally or artificially, the cracking precludes the possibility of a water-tight roof. As a substitute for concrete as a foundation, I believe that water-bound macadam cannot be improved upon.

For many years prior to the introduction of rubber-tired traffic, water-

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bound macadam had been conceded to be not only the best type of roadway for light horse-drawn traffic, as in parkways, but also for heavy country hauling. The only argument I have heard requiring an answer, as to the superiority of concrete over macadam, is the statement frequently made that it has greater bridging power. However, if the macadam is properly laid, and its sub-base properly prepared, it will spread any practical wheel-load over sufficient surface to give it support.

Water-bound macadam has but two faults as an ideal pavement for anything but congested city traffic. One of these is its tendency to disintegrate under motor traffic, and the other is its permeability to water. Both of these are overcome by the addition of an asphaltic wearing surface. Other advantages of macadam are its inherent stability, its lack of travel in the expansion and contraction of its aggregate, and its resiliency, which makes the wear on the surface less and a thinner wearing surface more practicable than in the case of unyielding concrete.

Anticlinal Dome Structure in California Oilfields

By DORSEY HAGER *

LITTLE attention has been directed to dome structure in California. The notes presented in this article are the result of a number of studies throughout the oilfields of Ventura and Los Angeles counties. Robert T. Hill, who is well known for his work in the Gulf coast states, accompanied me on a trip into Ventura county in the fall of 1912. On that trip Mr. Hill was struck by the occurrence of intersecting anticlines, and expressed the opinion that the intersections should be most favorable for the accumulation of oil. Mention is also made in Ralph Arnold's and Harry Johnson's government reports on the Coalinga and southern California fields of undulating and plunging anticlines, though they have not treated of the localization of oil due to these undulations that are herein classified as domes.

W. L. Watts, in Bulletin No. 19 of the California State Mining Bureau for 1900, makes reference to cross-folding and doming in the anticlines, as follows: "In many localities the rocks are found to be affected by more than one order of folds. In most instances we find dominant folds which have controlled the prevailing strike and dip of the formation, and cross-folds which have a different strike to that of the dominant folds. At points where the cross-faults strike the axes of the dominant folds, the tendency is to form dome-like elevations, or to occasion a great complexity of structure by plication and fracture." The map of Puente hills accompanying Mr. Watts' report, shows a cross-anticline east of the Puente Oil Co.'s wells. In company with A. A. Aultman, of Los Angeles, in 1912, I visited this section and found

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well defined doming in conjunction with several converging anticlines.

A dome or quaquaversal, shown in Fig. 1, 2, 3, and 4, is the result of an arching or bowing of the formations in such a manner that the formations slope or dip in all directions from a central point or apex. Domes may be circular or elliptical in shape. California operators have long known the simple anticline, but very few of them understand doming, or realize that what they considered simple anticlines are in reality domes or quaquaversals. As these domes occur along one main line or axis, like an anticline, the name anticlinal dome clearly describes such structures. Indeed, they are the high places along an undulating or waving anticline.

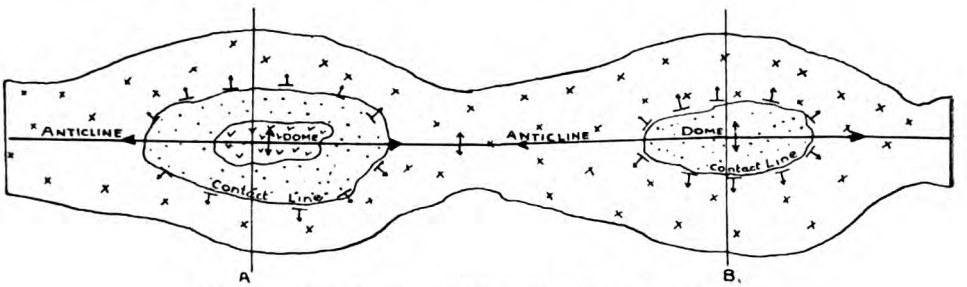

FIG. 1. GRAPHIC REPRESENTATION OF DOME STRUCTURE.

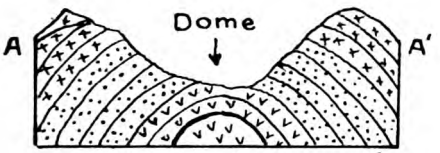

FIG. 2. CROSS-SECTION A-A'.

Importance in Relation to Petroleum.—The dome structure is the most favorable for the accumulation of oil. The oil rises from a large area to the apex of the dome. The concentration must necessarily be localized, as the tendency of the oil, where the oil strata are saturated with water, is to rise to the top of the dome, just as in an anticline the oil rises to the axis. As a result of doming, however, the oil is concentrated into a large reservoir around one point, instead of being concentrated along a line of the anticlinal axis.

Evidence of Domes.—In Ventura county, especially south of the Santa Clara valley, domes are found along one anticline at South mountain where the Oak Ridge Oil Co. has drilled one well, results not known; at Bardsdale, where the Union Oil Co. has been pumping wells for over twenty years; and at Oak Ridge, where the Montebello property is situated, 40,000 bbl. per month of 28°B. oil is now being produced per month. The Eureka Canyon wells are on another such dome. Farther east in the Santa Susanna mountains, several domes may be found, but as yet they have not been prospected to find whether or not they carry oil. Tests of these areas will prove very interesting. North of the Santa Clara valley, doming may be found in the San Cayetano mountains and Santa Paula ridge.

Los Angeles County.—In the Santa Susanna mountains domes occur; and at Fullerton, especially in the Coyote hills, and farther north along the Puente anticline, doming is very clearly shown.

Santa Maria.—At Santa Maria dom-

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ing is clearly evidenced in several places.

Coalinga.—Anticline ridge is part of a great anticlinal dome that is classified as a geanticline. The Jacalitos dome southwest of Coalinga may also be mentioned.

The Kettleman hills and the Lost hills domes are extensions along the one main Coalinga anticline which undulates to form anticlinal domes. Buena Vista hills may also be mentioned as an anticlinal dome. Numerous other domes are found in the oilfields, though not as prominently defined as the domes given above.

Cause.—The cause of these domes is not clearly apparent at present. Two distinct types of domes seem to exist. One type is due to cross-folding or the meeting of two sets of folds and the other type resulted from forces acting at angles of about 120° to one another. In parts of Ventura county as well as throughout the state, the axes of the main anticlines run N.W. and S.E. and rise and fall along their strikes. In some portions of the state, notably north of Santa Clara valley, another set of anticlines is found and which run N.E. to S.W. The obtuse angle between the two sets of folds, measures about 120°. Where the anticlines cross, doming is the result. The breaking up of the strata due to the intersecting folds results in a condition favorable for the migration of petroleum from lower to upper beds. This free migration and crumpling makes more favorable the chances of striking oil around a centre instead of along extended anticlines.

The intersecting of the anticlines also causes the older formation to rise closer to the surface. The principal folding is in the N.W.-S.E. direction. The second folding, which varies from E. and W. to N.E.-S.W., has not been so intense. In many places, especially south of the Santa Clara valley, the second folding has resulted in the bowing or doming along the anticline and caused undulations, though no distinct cross-anticlines occur.

To my mind, the change in strike of the South Mountain-Oak Ridge-Santa Susanna anticline from S.E.-N.W. to E. and W. to S.W.-N.E., has been caused by the effects of the two sets of forces, though no decided cross-anticlines are found *en echelon* to the main fold.

The San Joaquin valley anticlines show the effect of the two sets of forces. The dominant folds are still the N.W.-S.E., but the undulatory or wave effect of the anticlines causing the high nodes is the result of the set of forces that cause the N.E.-S.W. folds in other places. The greater number of the anticlinal domes throughout the state are of the type where but one strong fold is well developed, and the secondary folding results in waves along the main fold, the minor crumples occasionally occur on the main fold.

Graphical Representation of Dome Structure.—Domes are clearly shown by several different methods: (1) dips; (2) stratigraphy; (3) topography; and (4) cross-sections.

As shown in Fig. 1, the dips indicated by the little darts form an elliptical shaped structure. The plunges of the anticline are shown by the arrows on it. The plunges along the axis of the anticline are generally less than the dips away from the axis. Where the plunges are equal to the dips, the domes are circular. Elliptical domes are by far the most common. The major axis of the ellipses generally lie N.W.-S.E. Where the major axis lies in a S.W.-N.E. direction, the secondary forces have predominated.

On most geological maps, the formations are cross-hatched and colored, and

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for the purpose of illustration, cross-hatching has been used in the sketches accompanying this article. The older formations underlie the younger, but come to the surface at the apex of the domes, as shown in Fig. 1, 2, 3, and 4. The closing of the contact lines also shows doming. Note also that the con-

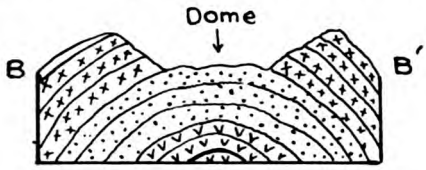

FIG. C. CROSS-SECTION B-B′.

tact lines are concave at the depressions and bow out at the domes. The topography shows the effect of the doming, but if the country is mountainous, as in Ventura county, the topography is complex and domes are not clear on a map, though they are clear to the eye and to the instruments. In open country like Kettleman hills and Buena Vista hills the topography is an excellent index of anticinal dome structure.

The cross-sections *A A′*, *B B′* and along the strike of the anticline, as shown in Fig. 2, 3, and 4, give an idea of the structure of anticlinal domes.

Conclusion.—Domes are very general throughout California. They localize the oil accumulations, which makes careful study necessary in locating wells. Domes are caused by two sets of forces, one causes N.W.-S.E. folds, the other S.W.-N.E. folds. A knowledge of these domes is essential to intelligent prospecting, as they make oil territory 'spotted.' Realization of this condition will save a great deal of money to California operators in the future.

The axis of an anticline is not sufficient in locating a well. The apex or high point of the anticlinal dome must be selected. Where the formations are not saturated with water, oil need not be expected at the apex of the dome, but must of necessity be around the dome and even in the depression. However, this latter case is a theoretical one that may account for failures to obtain oil on the apex domes. This article has been written in the hope of arousing discussion of a very important question, and I would like to see expressions from others who have studied the question.

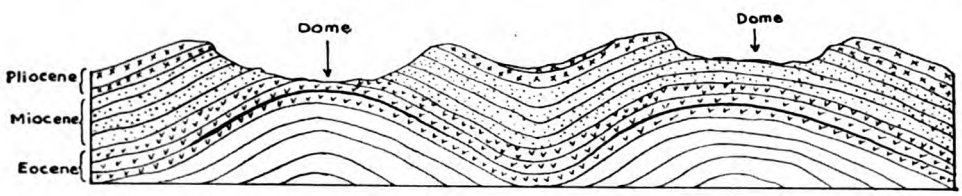

FIG. 4. CROSS-SECTION ALONG STRIKE OF ANTICLINE.

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The Engineering Digest

Fuel for Internal Combustion Engines*

By IRVING C. ALLEN

ON the Pacific and Gulf coasts of the United States, not to consider the increasing output in Mexico, there is produced a great quantity of heavy asphaltum oils. These may be refined and first-class products manufactured therefrom. In this refining, as also in the refining of the petroleums from the other oilfields of the United States, there is produced a so-called gas oil, which is that portion of the petroleum distilling between the heavy naphthas or kerosenes and the light spindle oils. It is too heavy for lamp oils or for burning in a gasoline engine, and is too light for lubricants. The United States Geological Survey states that there was produced in 1911 from the California and Gulf coast oilfields 101,381,285 bbl. of crude petroleum, valued at $50,942,446. This petroleum on refining would have yielded approximately 5%, or 5,069,064 bbl., of gas oil. From the other fields of the United States in 1911 there was produced 119,068,106 bbl. of crude petroleum, valued at $83,102,306, of which approximately 3%, or 3,572,043 bbl., was gas oil, making a total of 8,641,107 bbl. of gas oil.

This gas oil, as its name implies, can be cracked in hot retorts and an excellent illuminating gas made therefrom, or it may be burned with good results as a fuel under steam boilers.

By being mixed or blended with a small proportion of the low-boiling natural gasolines, gas oil can be enlivened by increasing its volatility and lowering its specific gravity and flash point, and made to burn in explosion engines. Even with the above uses, gas oil has been produced in greater quantities than can be efficiently consumed, and its profitable disposal has been a burden on the refiners. In the past few months, however, due to the enormous demand for gasoline, gas oil has been recracked in the stills at the refineries and a part converted into gasoline.

This led the Bureau of Mines to seek more efficient means for its use. The heavy oil internal-combustion engine—that is, the various modifications of the Diesel type—seemed to open a promising field, and a critical study of these engines abroad and in the United States has developed very encouraging results. A study of the use of gas oil in this engine has naturaly led to the study of other similar oils, and the fact has been developed that there is being produced in greater and greater quantities in the United States coal tars and tar oils from gas works and coke plants.

The fuel economy of the heavy-oil engine may be briefly summarized as follows: In a heavy-oil engine 200 to 250 gm., or approximately 0.4 lb., of oil is consumed in developed 1 hp-hr., whereas for a steam-engine of the best triple-expansion type, from 1.1 to 1.8 lb. is necessary. This difference in fuel consumption gives an efficiency of the oil-engine compared with the steamer of from 0.4 to 1.1 lb., or a ratio of approximately 1 to 3, or conservatively 10 to 25, in favor of the oil-engine.

The efficiency of coal as compared with fuel oil for steaming is variously estimated at 10 to 17, 10 to 15.5, and 10 to 16.1.

It may be of interest to note that a turbine engine taking steam from boilers fitted with the best Koerting burners for oil, with accessories complete, built by the Franco Tosi Co., Milan, and installed at the Turin

*Abstract from 'Technical Paper 37,' U. S. Bureau of Mines.

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Exposition in 1911, required 2½ or more times the weight of oil fuel per horse-power than did a Diesel engine built and installed by the same company at the same time and place for purposes of direct comparison, thus giving a ratio of 25 to 10 in favor of the Diesel engine.

Per unit of weight, not considering the relative storage capacities needed, the quantity of oil required for burning in an oil-engine compares with the quantity of coal required for steam production as 35 to 10, as shown from the following statement:

FUEL ECONOMY

Oil storage, 11.5, to coal storage, 10.

Calorific value of oil, 14, to calorific value of coal, 10.

Oil burned in an oil-engine, 25, to oil burned for steam production, 10.

One gallon of water at 15°C. weighs 8.3316 pounds.

The average specific gravity of California crude oils is 0.9574 at 15°C.

One barrel (42 gal.) of California crude oil weighs, therefore, 335 lb., and is equivalent to 1172.5 lb., or 0.58625 ton, of coal. From this ratio the cost of either fuel can be calculated from the market quotations.

The quantity of oil required in a heavy-oil engine and its resulting efficiency, estimated within a margin of about 5%, is approximately shown in the table following:

FUEL CONSUMPTION AND EFFICIENCY OF A HEAVY-OIL ENGINE

Load.	Pounds of oil per b.hp-hr.	Thermal efficiency (based on b.hp-hr.), %.....	Mechanical efficiency, %..
Full load	0.472	30	74
Three-quarter load...	0.500	..	65
Half load	0.562	26	58
One-quarter load	0.748	..	47

When one considers that in good steam boiler and engine units the ordinary thermal efficiency is only 12 to 13%, the advantage of the heavy-oil engine, for marine work particularly, is apparent.

The distribution of the total heating units from an oil when used in a Diesel engine is about as follows:

HEAT BALANCE OF THE DIESEL ENGINE

	Per cent.
Total heating value of fuel	100.0
Indicated horse-power	44.2
Brake horse-power	32.7
Friction of air, water, and oil pumps.	11.3
Cooling water	33.3
Exhaust gases	22.7

It has been stated that any fuel that will flow freely can be burned in a heavy-oil engine. Though this in a measure is true, heavy tarry oils, if not kept perfectly fluid by heating, will cool and tend to clog the pipes and valves. It is advisable, therefore, to first subject the tarry oils to a distillation, distilling over everything up to the tar residues or even to the cokes, and to use this distillate for fuel without further treatment. The cost of distillation will be outweighed by the more satisfactory running of the engine.

When the fuel oil is heavy and contains little volatile material, it is advisable to inject alongside the main fuel spray, by means of an auxiliary spray, a small quantity of an oil having a relatively low flash point, such as a heavy benzine or a gas oil. This ignition oil, lighting at the proper moment, will in turn ignite the more sluggish fuel oil, and proper ignition will thereby be insured. The ignition oil may also be injected within the fuel valve or first blended with the fuel itself in the storage tank.

Satisfactory ignition has resulted from injecting the following quantities of an oil of low flash point into the immediate neighborhood of the fuel-oil spray:

PERCENTAGE OF IGNITION OIL COMPARED TO WEIGHT OF FUEL

	Per cent.
At full load	1.5
At three-fourths load	6.9
At one-half load	12.7

SPECIFICATIONS FOR FUELS AND LUBRICANTS FOR HEAVY-OIL ENGINES

Fuels

The consensus of opinion seems to be that an oil to burn with success in heavy-oil engines should possess the following characteristics:

SOLIDIFYING POINT.—The oil should be mobile at 0°C. If it be heavy or viscous or contain a considerable proportion of asphaltum or paraffin, it will become sluggish

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and stiff at low temperatures, and considerable heat will have to be used to warm it before it can be run into the engine.

FLUIDITY.—Sluggish oils should first be heated before being introduced into the engine. If it be necessary to use very heavy oils, the engine should first be warmed by running on a more fluid fuel and the heavy oil introduced only after the engine is hot and running well. This process should be reversed when shutting down, and the heavy oils should be washed out of the engine valves and pipes with a lighter oil, the engine being run a short time on one of these lighter oils before it is allowed to become cold.

TAR CONTENT.—An oil should contain not more than 0.4% of material insoluble in xylene, as a larger proportion of insoluble material will tend to form coke in the cylinders. (Ten grams of the sample mixed with 10 c.c. of xylene shaken and filtered should show not more than 0.04 gm. increase on the filter.)

COKE RESIDUE.—The residue on coking should be not greater than 3%. A high content of asphaltum or free-carbon will give considerable trouble by coking in the cylinders.

FREE-CARBON CONTENT.—There should be not more than a trace of free-carbon in the oil, as free-carbon tends to clog the valves and to deposit on the surfaces of the cylinders.

VOLATILITY.—At least 80% of the oil should distill over at 350°C., for oil leaving more than 20% residue at this temperature will show a large carbon content by coking.

DISTILLATION.—Heavy oils and residues, though they may be successfully burned in a heavy-oil engine, should properly be distilled (not refined) before using, as it is cheaper to prepare the oil before introducing into the engine than it is to dismantle the engine, or a part of it, for cleaning.

FLASH POINT.—The flash point should be between 60 and 100°C. (Abel-Pensky closed tester). A small proportion of oil of a low flash point is required to insure ignition.

IGNITION OIL.—In general, a heavy oil containing no material having a low flash point should be enlivened by the addition of about 2% of a 'gas oil,' flash point 60 to 100°C. or less, before being fed into the cylinders.

SPECIFIC GRAVITY.—The specific gravity in itself, although of little significance, should be not greater than 0.920, because when greater the large proportion of heavy residual material would give trouble in the engine. In general, the boiling point or distilling proportion is of more importance.

CALORIFIC VALUE.—The heating value should be not less than 9000 calories, and the hydrogen content not less than 10%, as lower values are approaching the value of pure carbon and will give poor combustion.

SULPHUR CONTENT.—The sulphur content should be not more than 0.75%, as a greater proportion may attack the cylinder walls and will tend to pit them, making them rough. Brass, zinc, and copper are to be avoided in the surfaces exposed to combustion. Nickel steel seems to be the most resistant material.

ACID AND ALKALINE CONTENT.—The oil should contain no free ammonia, alkalies, or mineral acids, because of their pitting effect on the surfaces exposed to combustion.

ASH CONTENT.—The oil should contain not more than 0.05% of non-combustible mineral matter, because such matter tends to hasten carbonization within the cylinders and to prevent proper combustion.

WATER CONTENT.—The water content should be not greater than 1%. One per cent of water reduces the calorific value by 1%. Moreover, to raise the temperature of 1 gm. of water from room temperature, say 30°, to 100°C. requires 70 cal., and to evaporate 1 gm. of water at 100°C. into steam at 100°C. requires 536 cal. Hence 1 gm. of water causes a total reduction of 536 + 70, or 606 cal., and to raise the temperature of the steam to that of the cylinder requires still more heat. The absorption of heat in raising the temperature of the steam is partly compensated by the action of the steam in expanding and performing work on the piston, there being an abundance of heat in the cylinders. In short, 1% of water in the fuel itself will cause a loss of approximately 1.06% in the calorific value of the fuel. It must also be remembered that a drop of water suddenly generated into steam within the fuel spray at the instant of ignition may lower its temperature and thereby prevent ignition, and a number of such drops in succession might stop the engine.

RESIN CONTENT.—The resin content should be low, as resins have a tendency to carbonize readily and will tend to coke in the cylinders.

CREOSOTE CONTENT.—Oils containing creo-

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sotes up to 12%, though causing smoke to some extent, can be burned; a higher percentage of creosotes gives trouble by coking.

PARAFFIN CONTENT.—A paraffin content of 15% will give some trouble. An oil containing a still higher percentage of paraffin, because of the large quantity of oxygen necessary for complete combustion, will burn with more difficulty.

ASPHALTUM CONTENT.—The heavy-oil engine, at least so far as the use of asphaltum oils is concerned, is still in its experimental stage, but the assumption can fairly be made that when the mechanical difficulties are surmounted it will be practicable to burn any fuel oil containing asphaltum that is sufficiently fluid to flow, providing the oil be free from solid matter and water. An oil containing 21% asphaltum has been successfully burned.

ATOMIZATION.—Fine atomization is essential, for if the fuel enters the cylinder in drops of appreciable size, which can burn only from their surfaces, it will not have time for complete combustion. The fuel will consequently strike the sides of the cylinders and the piston head and there carbonize.

Lubricants

It is of importance to examine carefully the lubricating oils for use in cylinders and pumps.

VISCOSITY.—The viscosity should be between 9 and 10° Engler at 50°C. A lubricant of a much less viscosity would tend to burn and one of greater viscosity would tend to carbonize and would not lubricate so well.

SOLIDIFYING POINT.—The lubricant should be liquid at −5°C. and should not freeze solid above −10°C.

FLASH POINT.—The flash point should be between 220 and 240°C., Pensky-Martens closed tester.

CARBONIZATION.—When agitated with concentrated sulphuric acid the lubricant should lose not more than 10% by carbonization. This sulphuric-acid test gives an indication of the quantity of unsaturated hydrocarbons present.

SOLUBILITY.—The lubricant should dissolve completely and clearly in benzene.

ACIDITY.—The lubricant should be free from acids and alkalies, as these pit the metal surfaces, and free from resins and fats, as these saponify readily.

ANIMAL AND VEGETABLE OILS.—Because of their tendency to decompose, animal and vegetable oils should not be used.

Underground Water in Tularosa Basin, New Mexico

DURING the past two years the United States Geological Survey and the New Mexico Agricultural Experiment Station have been engaged in making a map and studying the underground waters of the large desert basin in south-central New Mexico, known as the Tularosa valley, through which the main line of the El Paso & Southwestern railroad now passes. At the north end of this basin, at present far from any adequate water supply, are the ruins of Gran Quivira, where a large community of Pueblo Indians lived until about 1672, when they were probably driven away by Apaches. Farther south are three volcanic cones, from the youngest of which a ribbon of black lava extends 43 miles down the valley. Still farther south is a plain of drifting gypsum sand, 270 square miles in extent, which resembles a great field of snow banks. Ever since the Mexicans with ox carts made their precarious expeditions into this strange region to obtain supplies of salt, travelers have gazed at the panorama that it affords and wondered how it could be put to greater use.

The recent investigations by the Government and the state will for the first time provide an adequate map of this region and give specific data as to the location and quality of desert water supplies and the availability of underground water for irrigation. According to this survey, the water-table (the upper surface of the strata that are saturated with water) is within 25 ft. of the surface in an area of 375,000 acres, within 50 ft. in about 800,000 acres, and within 100 ft. in about 1,150,000 acres. The soil of large parts of the shallow-water tracts is unsuitable for agriculture, but some parts contain loam soil that yields well when it is irrigated. In fully 100,000 acres the water-table is so near the surface that underground water is escaping into the atmosphere through evaporation.

The two most serious obstacles to irriga-

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tion with underground water in this valley are the comparatively small yields of wells, and the salty character of the water. Both of these difficulties have been carefully investigated. Although it is easy to drill or bore into the valley fill, it requires skill to finish wells in this material in such a manner as to develop the largest possible yields. Many of the failures in the past appear to have been due to improper methods of finishing. The water-bearing material is poorly assorted and consists largely of gravel with a sandy or clayey matrix that yields water but slowly. Every effort must be made to remove this matrix in order to develop around the well a bed of clean porous gravel that will transmit water freely.

The analyses show a great range in the amounts of salt and other mineral matter in the water. Some of the waters analyzed can safely be used for irrigation, others are too bad for any ordinary use, but the largest part are of intermediate character, containing undesirable amounts of salt, and yet probably being of value for irrigation if they are skilfully used. The best general method will probably be to use the mineralized underground waters in connection with flood waters in the areas in which flood waters can occasionally be obtained. The underground waters can be applied sparingly when necessary and can be conserved by dry-farming methods of cultivation; the flood waters can be used whenever they are available and in as large quantities as possible in order to wash the accumulated salt out of the soil.

Because of the limitations in regard to both quantity and quality of the underground supply and because of the cost of pumping, it is doubtful whether heavy irrigation, such as is commonly practised in the Rio Grande valley and other irrigation districts, will be feasible except very locally in the Tularosa basin; but the sparing use of well water to supplement rainfall and flood waters contains more promise and should be given a thorough trial. That a small amount of well water properly applied in supplemental irrigation in connection with careful methods of farming will add greatly to the yield of certain crops has been shown in results obtained on experimental farms and on the farms of certain thrifty settlers in many parts of the Southwest. The underground supply has the great advantage of being available whenever it is needed. Of course the pumping plant should be kept in repair so that break-downs will not occur at critical times. In times of drought a plant should be operated day and night at its full capacity.

The two important needs in Tularosa basin are (1) the careful and intelligent sinking of wells for the purpose of developing more and larger supplies of water for irrigation, and (2) the establishment of an experimental farm for the purpase of evolving a system of agriculture adapted to the conditions existing in this region.

One of the largest and best known of the springs in this region is Mal Pais spring, which is situated at the edge of the lava bed, less than two miles northwest of its south point, and which issues directly from a crevice in the lava. The water is salty and otherwise highly mineralized and is rated as unfit for human use except in necessity.

The wet land adjacent to the spring also contains much alkali, but lies at a sufficient elevation to be drained into Salt creek, which is five miles west. A more feasible project and one that would involve less expense would be to lead the spring water through a ditch to the uplands adjacent to the creek, where it could be used on soil containing less original alkali than the soil near the spring, where a certain amount of underdrainage would occur naturally, where deeper drainage could be effected by means of shorter and less expensive ditches, and where only the water actually used would have to be disposed of. In view, however, of the large amounts of alkali in the water of Mal Pais spring and the inferior quality of the soil in the region between this spring and Salt creek, it is doubtful whether any reclamation project dependent on this spring would be wholly successful.

Analysis of Water from Mal Pais Spring
(Parts per million.)

Total solids	5,500
Calcium (Ca)	739
Magnesium (Mg)	168
Sodium and potassium (Na + K)	748
Carbonate (CO_3)	60
Sulphate (SO_4)	2,367
Chlorine (Cl)	1,130
Calculated:	
Gypsum	2,378
Epsom salt	835
Common salt	1,864

The report embodying the results of this investigation, which will be published for

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free distribution, will contain several maps and a full discussion of the water resources of the region. Inasmuch as it will require considerable time to put the report through the Government Printing Office, this advance statement is given to the press and further notice will be given in the newspapers when the full report is ready for distribution. The investigation has been in charge of O. E. Meinzer, of the Geological Survey, and R. F. Hare, of the State Experiment Station, who have prepared the report referred to.

Humphrey Gas Pump Installation*

THE London water supply was recently enlarged by the construction of the Chingford reservoir of 3,000,000,000-imperial gallon capacity, which impounds water from the Lee river, and the installation of four Humphrey gas-pumps, which have a capacity of 33,600 U. S. gallons each per minute, and one with a capacity of 16,800 gal. per minute, against a head of 25 ft. This makes the supply 180,000,000 gal. per day. The Metropolitan Water Board was dissatisfied with the performance of several makes of pumps, so called for bids. The tenders, when opened, showed that the plant proposed by H. A. Humphrey would, inclusive of gas-plant, buildings, and foundations, cost $91,000 less than the lowest tender for a triple-expansion, steam-engine, centrifugal pumping-plant. There was moreover an enormous difference in the guaranteed fuel cost. The fuel consumption of the Humphrey pump was guaranteed not to exceed 1.1 lb. of anthracite per actual pump-horse-power hour, a penalty of $4800 being exacted for every 0.1-lb. consumption in excess of this figure. Anthracite is, of course, an expensive fuel, but even so, it was estimated that the fuel for the steam plant would, in practice, cost from two to three times as much as that for the Humphrey pumps, and the makers believe there is little doubt that the guarantee for these will be substantially bettered at trial. Another clause in the contract imposed a penalty of $96,000 should the plant prove a failure. It was a somewhat bold step to accept a contract under such heavy penalties for pumps 7 ft. in diam., and developing each between 200 and 300 hp., on the basis of an experimental pump with an output equivalent to about 35 hp. only; but the results have undoubtedly thoroughly justified Mr. Humphrey's confidence in the capabilities of his remarkable contribution to the progress of mechanical engineering.

As the Humphrey pump is still relatively new, it may be a convenience to many readers if a short description of its mode of operation is given before describing in more detail the pumps supplied to Chingford.

Fig. 1 represents a diagrammatic view of the Humphrey pump in its simplest form. It consists merely of a bent pipe terminating at one end in the delivery-tank, and at the other in a combustion chamber, in which the charge of gas and air is exploded over the surface of the water. When such a charge has been fired, the pressure above the water surface sets the whole column of water in motion, the hot gases expanding above it. Once the column of water is set in motion, its inertia carries it forward, so that the pressure of the gases in the combustion chamber ultimately falls below that of the atmosphere, and as a result the exhaust-valve *E* opens under its own weight. The forward motion of the water continuing, the level in *C* finally falls below that of the water in the supply-tanks *S T*, and fresh water then enters through the valves *V*. Finally, the momentum being exhausted, the water begins to flow back along the play-pipe *D*, and rising in the chamber *C*, closes the valve *E* by impact, trapping above this level a cushion of the spent gases mixed with a large proportion of air which was drawn in through a scavenger-valve, not shown in the figure, during the forward motion of the water. This cushion of air is compressed into the head of the chamber by the continued return of the water-column, the latter being thus finally brought to rest, in which condition the pressure of the cushion is much above that due to the static head. As a consequence the water-column begins a second forward oscillation, in the course of which the pressure in the cushion space falls again below that of the atmosphere. By means of interlocking gear, the exhaust valve *E*, and the scavenger valve, are now prevented from opening, but the valve shown at *A* being simultaneously un-

*Abstract from *Mining and Scientific Press*, June 28, 1913.

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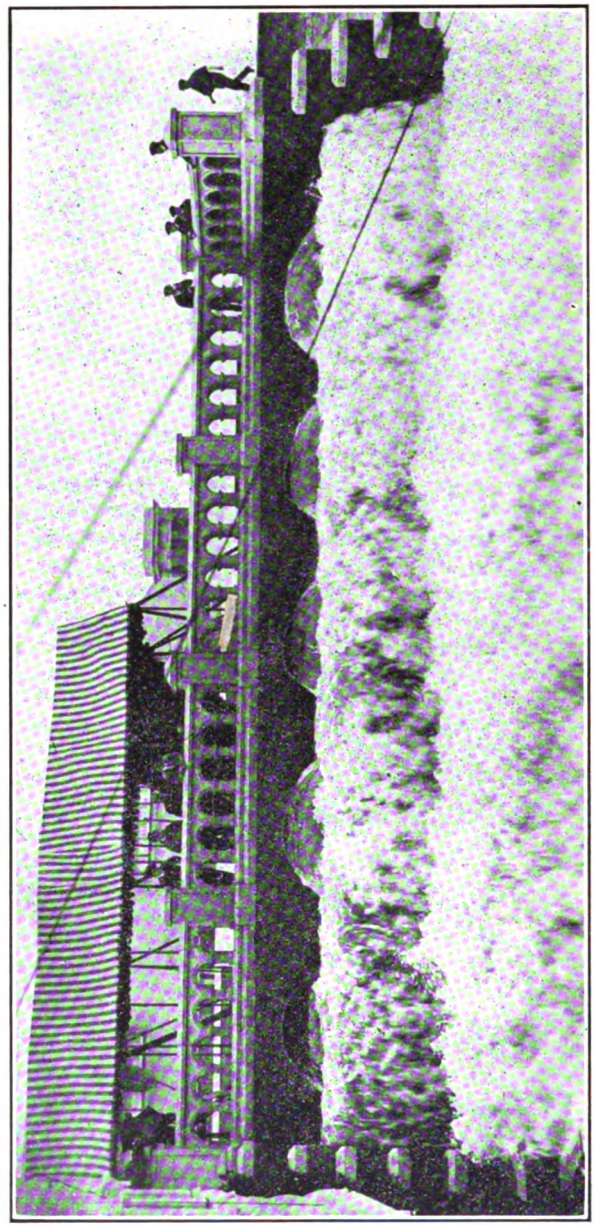

DISCHARGE AT THE CHINGFORD RESERVOIR PUMPING STATION.

locked, a charge of gas and air enters the chamber.

When the forward momentum of the water-column has been exhausted a second time, a return flow takes place, which compresses the new charge and fires it automatically at the proper time, thus starting a fresh cycle of operations. This working cycle, it will be seen, involves, in the first place, a long out-stroke, during which the exploded charge is expanded down to and below the atmosphere, the in-drawing of scavenging air, and the entrance into the pump of a fresh supply of water. This is followed by a return stroke, during which the spent gases are driven out through the exhaust valve, after which the latter is closed, and a cushion compressed in the head of the pump-chamber. Next comes a short out-stroke, during which a fresh

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charge of air and gas enters the pump, while a return stroke, compressing and finally firing this charge, completes the cycle. The pump has the thermo-dynamic advantage down to about 45-lb. absolute, or so. An indicator driven by clock-work at a uniform rate, if fitted to the pump, gives a diagram of the type shown in Fig. 3. Here, from *A*

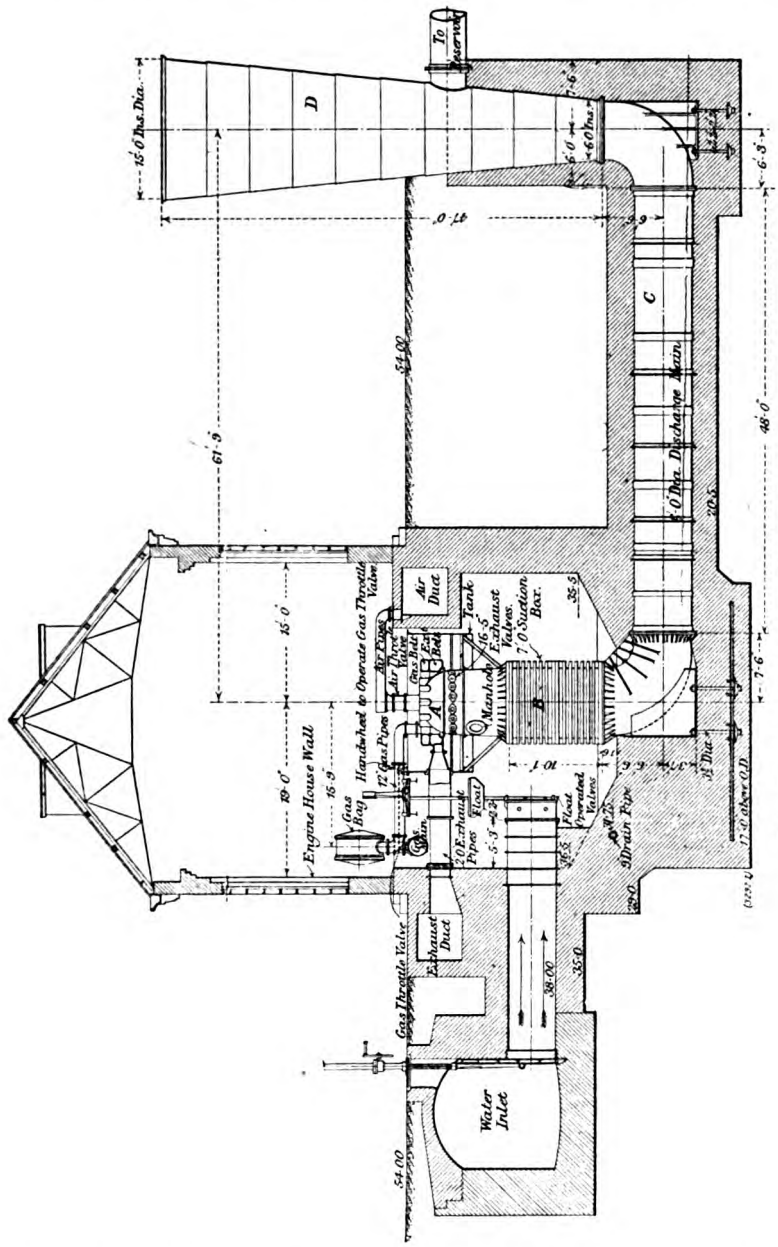

FIG. 2. ELEVATION OF PUMPING STATION.

that the charge is expanded down to atmosphere, thus utilizing the so-called 'toe of the diagram,' which is lost in the case of the ordinary gas-engine, in which the charge, before being exhausted, is only expanded to *B*, the charge is compressed, being fired at *B*, which causes the pressure to rise to *C*; from *C* to *D* the gases expand doing work. The exhaust valve opens at *D*, and from *D* to *F* the pressure in the pump-chamber re-

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mains atmospheric. At *F*, the exhaust valve closes, and compression of the cushion takes place; and it will be seen that the maximum pressure attained on this return stroke is in this case higher than the explosion pressure. From *G* to *H* the cushion expands, and at *H* the air-valve opens, closing again at *J* on the return of the water-column to compress the new charge, *J* being the point at which a fresh cycle of operations is started.

In principle the pumps erected at Chingford differ in no respect from the form illustrated in Fig. 1, but in place of single large valves for admitting, for scavenging, and for

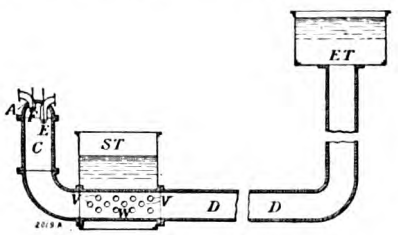

Fig. 1.

exhausting the charge, a number of smaller valves are used. The general view, Fig. 2, shows in elevation one of the 40,000,000-gal. per diem units. Of these there are four, having pump cylinders 7 ft. in diameter, while the fifth pump, rated at 20,000,000 gal.

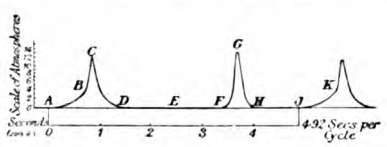

Fig. 3.

per day, has a barrel 5 ft. in diameter. Each pump consists of a cast steel head *A*, into which the explosive charge is compressed and fired, and a water-suction valve box *B*, from which a play-pipe *C* leads to the base of a water-tower *D*, built up of riveted plates. From each of these towers, a 4-ft. pipe leads over the top of the reservoir embankment, and discharges into the uppermost of a series of water-cushions extending to the bottom of the reservoir. The supply of water is led along the back of the pump-house through a conduit formed in the concrete, as clearly shown in Fig. 2. From this, a cast iron pipe, embedded in concrete, is led into each of the five pump-pits. Sluice-valves are provided, as indicated in Fig. 2, by which each pit can be shut off when desired. A working platform is fixed around the pump-head as indicated, giving access to the valves and other operating gear. The play-pipe *C*, is, it will be seen, also embedded in concrete into which, moreover, it is keyed by its flanges. The air-duct for the supply of the pumps is arranged below the floor-level on the right of the building, as shown in Fig. 3, and the exhaust-duct by which the spent gases are passed into the atmosphere on the left. Owing to these gases being exhausted at atmospheric pressure, the pump works practically without noise, and the smooth working absence of shock, and freedom from vibration, are truly remarkable.

The bend which connects the bottom of the suction-box to the play-pipe is a steel casting of unusually large dimensions, and its bore tapers from 7 to 6 ft. It serves to anchor the pump-chamber securely to the foundation against the up-lift, due to the fact that the full pressure of each explosion does not reach to the bottom of the bend, a part being absorbed in the mass acceleration of the intervening fluid. The fuel required for operating the pumps is supplied from a Dowson gas plant. This consists of four producers, one of which is rated to convert into gas 138 lb. of anthracite per hour, and the other three, 370 lb. each. A cooling-pipe leads from the top of each producer to a corresponding coke-scrubber. The steam required is supplied by three vertical boilers. One boiler is a stand-by. In all, seven coke-scrubbers are provided, there being two arranged in series for each of the larger producers, while one scrubber only is fitted for the smaller plant. After passing the coke-scrubber the gas is sent through a sawdust scrubber, of which one is provided for each producer, and it is then led through an underground conduit to a gas-holder, 24 ft. in diameter and 12 ft. high. A governing-gear is fitted, by which the rise of the gas-holder regulates automatically the rate at which steam is admitted to the producers, thus keeping the rate of production of gas the same as the rate of consumption.

The pumps now working were constructed from the designs of the Pump & Power Co., Ltd., by Siemens Brothers Dynamo Works, Ltd., Stafford, England, the former being represented in the United States by the Humphrey Gas Pump Co., Syracuse, New York, which kindly supplied these notes and illustrations.

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United States Government Permits for Power Development

IN furtherance of the policy recently announced by Secretary Lane with respect to the use of public lands and navigable streams in the development of electric power in such manner as to lower the rate charged to consumers, to inhibit combination or monopoly, and to secure public control over rates and service, while at the same time according to the developing companies a reasonable time for finding or creating a market, and such a tenure during proper use of the grant, as will promote and encourage the development of this important public resource, there has been jointly approved by Acting Secretary Jones, of the Interior Department, and Secretary Houston of the Department of Agriculture, a power permit to the International Power & Manufacturing Co. for the development of a large power project on Clark's Fork, or the Pend Oreille river, in Pend Oreille county, state of Washington.

The project covered by this permit is one of the largest in the United States and offers exceptional opportunity for the development of remarkably cheap power. At lowest stages the stream-flow is sufficient for the development of about 120,000 continuous horse-power and by use of storage facilities upon the stream above 350,000 hp. can eventually be developed during years of low precipitation.

The plan of development in which the company agreed to heartily coöperate is under a *permit indeterminate as to time but revocable*, after due notice and opportunity for hearing, *for violation of the terms* of the permit, of the provisions of the general regulations, or pursuant to the provisions of the Act of Congress of February 15, 1901. Other novel and important provisions of the permit are: *fixing of maximum rates* which may be charged to small and large consumers and customers; provisions to *prevent unlawful combinations or evasion of the conditions of the agreement* and *for the regulation of service* and *prescribing of prices by public authority;* fixing of a *specific time limit within which to begin and complete the project works* and installing the hydro-electric and electric machinery; requirement of *continuous operation of project works* except on showing of unavoidable accident or unforeseen contingencies; while for the purpose of securing light, heat, and power to the small consumers at the lowest possible rate and for promoting and encouraging manufacturing enterprises in the regions reached by the company's transmission lines provisions are made to encourage and aid the company in the development and use of the site, among such provisions being the allowance of *a ten-year period without charge while project works are being built and while the company is finding or creating a market.*

Agreement

The following terms, wherever used in this agreement, shall have the respective meanings in this section assigned to them:

'Interior Department lands' means lands under the jurisdiction of the Department of the Interior for the purposes of the Act of Congress approved February 15, 1901 (31 Stat., 790), and 'national forest lands' means lands under the jurisdiction of the Forest Service of the Department of Agriculture for said purposes.

'Secretaries' means the Secretary of the Interior and the Secretary of Agriculture.

'Power business' means the entire business of the applicant or permittee in the generation, distribution, and delivery of power by means of any one power system, together with all works and tangible property involved therein, including freeholds and leaseholds in real property.

'Power system' means all interconnected plants and works for the generation, distribution, and delivery of power.

'Power project' means a complete unit of power development, consisting of a power-house, conduit or conduits conducting water thereto, all storage or diverting or fore-bay reservoirs used in connection therewith, the transmission line delivering power therefrom, and any other miscellaneous structures used in connection with said unit or any part thereof, and all lands the occupancy and use of which are necessary or appropriate in the development of power in said unit.

'Project works' means the physical structures of a power project.

'Construction of the project works' means the actual construction of dams, water conduits, power-houses, transmission lines, or some permanent structure necessary to the operation of the complete power project and

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does not include surveys or the building of roads and trails, or the clearing of reservoir sites or other lands to be occupied, or the performance of any work preliminary to the actual construction of the permanent project works.

'Customer' means the purchaser of electric current for redistribution and sale.

'Consumer' means the user of current at the point of its final conversion into light, heat, or power.

'Nominal stream flow' means the sum of (*a*) the average of the values estimated for the mean natural flow for the two-month (calendar) minimum-flow period in each successive five-year cycle or major fraction thereof, and (*b*) the increase in such average due to artificial means other than the project works.

'Project storage flow' means the estimated increase in nominal stream flow made practicable by the project works.

'Available stream flow' means the sum of nominal stream flow and project storage flow.

'Load factor' means the ratio of average power output to maximum power output.

'Total capacity of the power site' means the power estimated to be available for transmission, and is determined as the continued product of (1) the factor 0.08; (2) the average effective head, in feet; (3) the available stream flow at the intake (in second-feet and in amount not to exceed the maximum hydraulic capacity of the project works); and (4) a factor, not less than the average load factor of the power system, representing the degree of practicable utilization of the available stream flow, and based on the extent of practicable fore-bay storage and the load factor of the power system.

The permit shall be subject to and the permittee shall be governed by the provisions of the Act of Congress approved February 15, 1901 (31 Stat., 790), and to the regulations thereunder fixed by the Secretaries.

The permit shall relate solely to the occupancy and use of the Interior Department lands and national forest lands necessary for the construction, operation, and maintenance of such works contemplated by the Act of Congress approved February 15, 1901 (31 Stat., 790), as are described in the final application, to the extent of the ground occupied by such works and not to exceed 50 ft. on each side of the marginal limits of works other than pipe-lines and electrical transmission lines and not to exceed 50 ft. on each side of the centre of each pipe-line or electrical transmission line, in conformity with the location of such works on said lands as shown by the maps of location hereinbefore described.

The permittee shall construct the project works on the location shown upon and in accordance with said maps and plans submitted with the final application, and shall make no material deviation from said location unless and until maps and plans showing such deviation shall have been submitted and approved by the Secretaries.

Any approval of any alteration or amendment, or of any map or plan, or of any extension of time, shall affect only the portions specifically covered by such approval; and no approval of any such alteration, amendment, or extension shall operate to alter or amend, or in any way whatsoever be a waiver of any other part, condition, or provision of the permit.

The permittee shall begin the construction of the project works and of the several parts thereof and shall thereafter diligently and continuously prosecute such construction to completion unless temporarily interrupted by climatic conditions or by some special or peculiar cause beyond the control of the permittee, within the respective periods, dating from the issuance of the permit, specified for such beginning and for such completion in the following schedule:

Project works as a whole, excepting installation of hydraulic and electric machinery, shall be begun within one year and completed within three years.

Installation of hydraulic and electric machinery: machinery of 50,000 hp. rated capacity shall be installed within three years; and additional machinery shall be installed as the conditions of the market will warrant or as the secretaries or any duly authorized state agency may direct.

The permittee shall, after their completion, operate the project works continuously for the development and transmission of electric energy for sale or other disposal, unless upon a full and satisfactory showing that such operation is prevented by unavoidable accidents or contingencies, this requirement is temporarily waived by the written consent of the Secretaries.

No compensation for the permission given will be required prior to the year 1923;

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but on or before the first day of February in each year, beginning with 1924, the permittee shall pay, by certified check to the order of the Secretary of the Interior, or in such other manner as the Secretaries may direct, an amount calculated from the total capacity of the power-site at rates per horse-power per year varying directly as the square of the average price for electric energy charged to customers and consumers of the permittee as determined in subsection (c) hereof and varying inversely as the square of the proportional development of the power-site, as shown by the following table:

When the average price in cents per kilowatt-hour charged by the permittee is as shown by this column.	If the percentage of development of power site is—						
	Over 90.	90 and over 80.	80 and over 70.	70 and over 60.	60 and over 50.	50 and over 40.	40 or less.
	Then the rates of compensation to the United States per horsepower per year will be as shown below.						
0.2 and less	$0.05	$0.06	$0.08	$0.10	$0.14	$0.20	$0.31
0.3 and over 0.2	.11	.14	.18	.23	.31	.45	.70
0.4 and over 0.3	.20	.25	.31	.41	.56	.80	1.25
0.5 and over 0.4	.31	.39	.49	.64	.87	1.25	1.95
0.6 and over 0.5	.45	.56	.70	.92	1.25	1.80	2.81
0.7 and over 0.6	.61	.76	.96	1.25	1.70	2.45	3.82
0.8 and over 0.7	.80	99	1.25	1.63	2.22	3.20	5.00
0.9 and over 0.8	1.01	1.25	1.58	2.06	2.81	4.05	6.33
1.0 and over 0.9	1.25	1.54	1.95	2.55	3.47	5.00	7.81
1.2 and over 1	1.80	2.22	2.81	3.67	5.00	7.20	11.25
1.5 and over 1.2	2.81	3.47	4.40	5.74	7.82	11.25	17.60
2 and over 1.5	5.00	6.17	7.82	10.00	13.80	20.00	31.25
3 and over 2	11.25	13.87	17.58	22.95	31.25	45.00	70.40
4 and over 3	20.00	24.70	31.25	40.80	55.60	80.00	125.00
5 and over 4	31.25	38.60	48.80	63.80	86.80	125.00	250.00
6 and over 5	45.00	55.60	70.40	91.80	125.00	180.00	281.25

It is expressly understood and agreed, however, that—

At any time not less than ten years after the date for the first payment under this section or after the last revision of the rates of compensation the Secretaries may review such rates after application by or notice to the permittee and impose such new rates of compensation, under a rule which shall be uniform for all permittees under like conditions, as they may decide to be reasonable and proper: *Provided*, That such rates shall not be so increased as to result in reducing the margin of income (including appreciation in land values) from the project over proper, actual, and estimated expenses (including reasonable allowance for renewals and sinking-fund charges) to an amount which, in view of all the circumstances (including fair development expenses and working capital) and risks of the enterprise (including obsolescence, inadequacy, and supersession), is unreasonably small; but the burden of proving such unreasonableness shall rest upon the permittee.

For the purposes of this section complete development of the power-site shall mean the construction of such permanent project works and the installation of such generating equipment as will provide for the full utilization of the total capacity of the power-site.

The average price for electric energy charged to customers and consumers of the permittee shall be determined by dividing the total actual and estimated annual receipts from the sale and disposition of electric energy by the total number of kilowatt hours generated: *Provided*, That in determining said total annual receipts there shall be included estimated receipts for any electric energy used by the permittee at a price which shall not be less than 2c. per kilowatt-hour, nor less than the cost per kilowatt-hour of generating, transmitting, and delivering such energy to the point of use, taking into account proper operating and maintenance expenses, fixed charges, and reasonable allowances for renewals and sinking fund: *And provided further*, That if the permittee shall sell or dispose of electric energy to any consumer, said consumer being an association or corporation which the permittee owns or controls in whole or in part, or in which the permittee may have, hold, or control any interest, direct or indirect, by stock ownership or otherwise, the sale price per kilowatt-hour at which the aforesaid annual receipts from such energy so sold or disposed of shall be com-

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puted shall not be less than as herein provided for in the computation of estimated receipts for energy used by the permittee: *And provided further*, That if the permittee shall sell or dispose of electric energy to any customer, said customer being an association or corporation which the permittee owns or controls in whole or in part, or in which the permittee may have, hold, or control any interest, direct or indirect, by stock ownership or otherwise, the sale price per kilowatt hour at which the aforesaid annual receipts from such energy so sold and disposed of shall be computed shall not be less than the price paid for such energy by the consumers thereof, nor less than as herein provided for in the computation of estimated receipts for energy used by the permittee.

Unless otherwise authorized by the Secretaries, the maximum price at which electric energy developed by or transmitted from the power project may be disposed of to customers or consumers shall not exceed 6c. per kilowatt-hour, and the maximum price at which such electric energy in excess of 2000 kw-hr. per annum with an average annual delivery of more than 35% of the connected installation within the year may be disposed of to customers or consumers shall not exceed 2c. per kilowatt-hour, said maximum price being determined by dividing the total annual charge to the purchaser by the corresponding total annual delivery to him of electric energy. In contracts with its customers the permittee shall specify the maximum price of final sale or resale and shall reserve the right to cancel any contract or agreement for sale or resale of electric energy that provides for a price in excess of such maximum. Complaint by any customer or consumer of a price paid by him in excess of such maximum price will be received by the Secretaries in case of and after the failure of his attempts to obtain satisfaction from the permittee or other parties selling electric energy under the power system, and thereupon, after notice to all interested parties, with opportunity for hearing, the Secretaries will determine whether this condition has been violated.

The permittee shall at no time contract for the delivery to any one customer of electric energy in excess of 50% of the total deliverable capacity of the power-site; nor shall the permittee [illegible] or consumer [illegible]

turing or other operations any amount of energy in excess of 50% of said deliverable capacity if and when there are pending unfilled applications for energy from other customers and consumers.

The total capacity of the power-site shall be deemed and taken to be 112,000 horsepower.

It is expressly understood and agreed, however, that said total capacity of the power-site may be adjusted by the Secretaries annually to provide for increase or decrease, by storage or otherwise, of available stream flow to an amount of 10% or more, or for increase or decrease of 10% or more in average effective head, or in degree of practicable utilization, and that the decision of the Secretaries shall be final as to all matters of fact upon which the calculation of the capacity or compensation depends.

The permittee shall pay the full value as fixed by the Secretaries for all timber cut, injured, or destroyed on Interior Department lands and on national forest lands in the construction, maintenance, and operation of the project works.

The permittee shall pay the United States full value for all damages to the lands or other property of the United States resulting from the breaking of or the overflowing, leaking, or seeping of water from the projects, works, and for all other damage to the lands or other property of the United States caused by the neglect of the permittee or of the employees, contractors, or employees of the contractors of the permittee.

The permittee shall install at such places and maintain in good operating condition in such manner as shall be approved or required by the Secretaries accurate meters, measuring weirs, gauges, or other devices approved by the Secretaries and adequate for the determination of the amount of electric energy generated by the project works and delivered under the power system and of the flow of the stream or streams from which the water is to be diverted for the operation of the project works and of the amount of water used in the operation of the project works and of the amounts of water held in and drawn from storage; and shall keep accurate and sufficient records of the foregoing determinations to the satisfaction of the Secretaries; and shall make [illegible]uring January of each year under [illegible]f the records of measurements [illegible]nded on December 31 preced-

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ing made by or in the possession of the permittee as may be required by the Secretaries.

The books and records of the permittee shall be open at all times to the inspection and examination of the Secretaries, or other officer or agent of the United States duly authorized to make such inspection and examination.

On demand of the Secretaries the permittee shall install a system of accounting for the entire power business in such form as the Secretaries may prescribe, which system, as far as is practicable, will be uniform for all permittees, and shall render annually such reports of its power business as the Secretaries may direct: *Provided, however*, That if the laws of the state in which the power business or any part thereof is transacted require periodical reports from public utility corporations under a uniform system of accounting, copies of such reports so made will be accepted as fulfilling the requirements of this clause in so far as they contain the information that may be required by the Secretaries.

The permittee shall protect all Government and other telephone, telegraph, and power transmission lines at crossings of and at all places of proximity to the permittee's transmission lines in a workmanlike manner according to the usual standards of safety for construction, operation, and maintenance in such cases, and shall maintain the transmission lines of the project in such manner as not to menace life or property.

The permittee shall clear and keep clear the Interior Department lands and national forest lands along the transmission lines for such width and in such manner as the officer of the United States having supervision of such lands may direct.

The permittee shall dispose of all brush, refuse, or unused timber on Interior Department lands and national forest lands resulting from the construction and maintenance of the project works to the satisfaction of the officer last aforesaid.

The permittee shall build and repair such roads and trails as may be destroyed or injured by construction work or flooding under the permit and shall build and maintain necessary and suitable crossings for all roads and trails that intersect the water conduit constructed, maintained, or operated under the permit.

The permittee shall do everything reasonably within the power of the permittee, both independently and on request of the Secretaries or other duly authorized officers or agents of the United States to prevent and suppress fires on or near the lands to be occupied under the permit.

The permittee shall indemnify the United States against any liability for damages to life or property arising from the occupancy or use of Interior Department lands and national forest lands by the permittee.

The permittee shall sell power to the United States, when requested, at as low a price as is given to any other purchaser for a like use at the same time, and under similar conditions, if the permittee can furnish the same to the United States without diminishing the quantity of power sold before such request to any other customer by a binding contract of sale: *Provided*, That nothing in this clause shall be construed to require the permittee to increase permanent works or install additional generating machinery.

The permittee shall abide by such reasonable regulation of the service rendered and to be rendered by the permittee to consumers of power furnished or transmitted by the permittee, and of prices to be paid therefor as may from time to time be prescribed by the state or any designated agency of the state in which the service is rendered: *Provided*, That for the purposes of this section any such regulation shall be deemed to be suspended pending proceedings in the courts of such state, or in the Supreme Court of the United States on appeal from said state courts where such proceedings are in the nature of an appeal taken direct from the officer, commission, or board prescribing such regulation to said state courts: *And provided further*, That in the absence of regulation of service and prescribing of prices by any state agency, jurisdiction in the premises will, in their discretion, be exercised by the Secretaries.

Upon demand in writing by the Secretaries to surrender the permit to the United States or to transfer the same to such state or municipal corporation as the Secretaries may designate, and to give, grant, bargain, sell, and transfer with the permit all works, equipment, structures, and property then owned or held by the permittee on lands of the United States occupied or used under the permit and then valuable or serviceable in the generation, transmission, and distribution of power: *Provided*, (*a*) That such surrender or transfer shall not be demanded

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in the case of a municipal corporation unless by condemnation such corporation shall have acquired, or unless by proceedings in a court of competent jurisdiction it shall have been determined that such a municipal corporation has the right to acquire the property of the permittee situated elsewhere than on public land, or unless such municipal corporation has the power to acquire the property and rights of the permittee in accordance with the following conditions: (*b*) That such surrender or transfer shall be on condition precedent that the United States shall pay or the transferee shall first pay to the permittee the reasonable value of all such works, equipment, structures, and property to be surrendered or transferred; (*c*) That such reasonable value shall not include any sum for any permit, right, franchise, or property granted by any public authority in excess of the sum paid to such public authority as a purchase price therefor; and (*d*) That such reasonable value shall be determined by mutual agreement of the parties in interest, and in case they cannot agree, by the Secretaries under a rule which, except as modified by the requirements of this section, shall be the then existing rule of valuation for power properties in condemnation proceedings in the state in which the properties to be surrendered or transferred are located. But nothing herein shall prevent the United States or any state or municipal corporation from acquiring by any other lawful means the permit or the works, equipment, structures, or property then owned or held by the permittee on lands of the United States occupied or used under the permit.

In respect to the regulation, by any competent public authority, of the services to be rendered by the permittee or of the prices to be charged therefor, and in respect to any purchase or taking over of the properties or business of the permittee or any part thereof by the United States or by any state within which the works are situated or business is carried on in whole or in part, or by any municipal corporation in such state, no value whatsoever shall at any time be assigned to or claimed for the permit or for the occupancy or use of Interior Department lands or national forest lands thereunder, nor shall the permit or occupancy or use ever be estimated or considered as property upon which the permittee shall be entitled to earn or receive any return, income, price, or compensation.

The works to be constructed, maintained, and operated under the permit shall not be owned, leased, trusteed, possessed, or controlled by any device or in any manner so that they form part of, or in any way effect any combination in the form of an unlawful trust, or form the subject of any unlawful contract or conspiracy to limit the output of electric energy, or in restraint of trade with foreign nations or between two or more states, or within any one state in the generation, sale, or distribution of electric energy. Except as in this agreement specifically provided, the permittee shall not agree or arrange in any manner whatsoever with any other party generating or disposing of electric energy with a view to the avoidance of competition or the fixing, maintenance, or increase of prices for electric energy or service.

This permit shall be indeterminate as to time during compliance with the conditions of this agreement by the permittee, or until the United States or any state or municipal corporation shall exercise its option to purchase as provided. It is expressly understood and agreed, however, that the permit may be revoked by the Secretaries, after due notice to the permittee with opportunity for hearing, on a finding by them that any part of the amounts due for the compensation or the charges herein provided for, after due notice has been given, are in arrears for six months; or on a finding by the Secretaries that any of the provisions of this agreement or any of the regulations of the Secretaries or the provisions of the Act of Congress to which the permit is subject as provided have been violated by the permittee.

It is further understood and agreed that under the terms of said Act of Congress "any permission given by the Secretary of the Interior under the provisions of this act may be revoked by him or by his successor in his discretion."

It is further understood and agreed that at intervals of not less than twenty years, on application of the permittee or on demand of the Secretaries, this agreement and the permit shall be modified to conform to the then subsisting regulations fixed by the Secretaries under said act of February 15, 1901, or amendments thereto.

The permittee shall in the exercise of the permission given by the permit, at all times conform to and abide by such rules and regulations subserving the purpose of any

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reserved lands of the United States through which right of way is sought as may be prescribed by the officer having jurisdiction over such lands.

The permit does not affect the rights to the occupancy of lands granted by the state of Washington or any rights, privileges, or franchises conferred upon the permittee by virtue of the Act of Congress approved February 25, 1907 (34 Stat., 931), as amended by the Act of Congress approved May 20, 1912 (37 Stat., 115), entitled "An act to extend the time for the construction of a dam across the Pend Oreille river, Washington," or impair or affect the rights conferred upon the said permittee by compliance with the provisions of the Act of Congress approved June 23, 1910 (36 Stat., 593), entitled "An act to regulate the construction of dams across navigable waters."

On proper application by the permittee under subsisting regulations fixed by the Secretaries, the permit may be amended to provide for the construction, operation, and maintenance of additional project works and the use of additional rights of way for the power project. Any application for such amendment and approval thereof shall be in the form of a supplemental agreement and permit so drawn as to become a part of the original agreement and permit.

The permit and the right of way thereby afforded shall be subject to all prior valid rights and to a reservation of right of way for canals or ditches constructed by authority of the United States.

The Cost of Generating Power With Deisel Oil Engines*

By GORDON KRIBS†

THE Diesel oil-engine was invented by Rudolf Diesel, the first working engine being produced in 1897. Since that time they have been gradually perfected until they have become a most reliable and efficient source of power. The demand for

Sherman Gas and Electric Company's 3—16—24 Diesel Engine No. 138.

Time	Volts	Amp.	Volts	Amp.	W-Mtr.	R.P.M.	Oil	O. Com. Gals	Air-P.	K.W.
5 p.m.	242	640	247	650	4876.0	162	—	—	72 a.t.m.	—
6 "	238	635	245	640	4891.3	164	3.0	—	72 "	153.3
7 "	242	635	243	650	4907.0	164	19.0	16.0	71 "	156.7
8 "	237	640	246	640	4922.4	164	34.5	15.5	71 "	154.0
9 "	240	655	243	665	4938.3	163	18.0	15.5	70 "	159.0
10 "	240	650	241	665	4954.2	163	14.5	14.5	70 "	159.0
11 "	243	620	240	675	4970.0	164	15.5	15.5	67 "	158.0
12 "	240	640	242	665	4985.8	163	14.5	14.5	69 "	158.0
1 a.m.	238	640	243	665	5001.7	104	13.0	13.0	—	159.0
2 "	240	640	242	662	5017.5	164	28.0	15.0	69 "	158.0
3 "	239	655	242	670	5033.2	163	14.0	14.0	69 "	157.0
4 "	240	650	242	670	5049.1	165	28.5	14.5	69 "	159.0
5 "	240	650	242	670	5065.2	164	14.5	14.5	69 "	161.0
6 "	240	655	242	675	5081.2	164	29.0	14.5	69 "	160.0
7 "	239	665	242	680	5097.2	164	14.0	14.0	69 "	160.0
8 "	238	670	241	690	5113.0	163	28.5	14.5	70 "	158.0
9 "	238	670	240	680	5129.0	163	14.0	14.0	70 "	160.0
10 "	239	665	241	680	5145.2	163.5	29.3	15.3	70 "	162.0
11 "	240	655	243	660	5161.25	164	13.5	13.5	70 "	160.5
12 "	238	665	241	675	5177.5	164	28.25	15.25	70 "	162.5
1 p.m.	238	665	241	675	5193.2	164	14.0	14.0	70 "	157.0
2 "	240	670	243	675	5209.5	162	29.5	15.5	70 "	163.0
3 "	242	660	244	665	5225.66	162	15.¼	15.75	70 "	161.6
4 "	246	655	250 251	655	5242.4	160 161	33.¼	19.5	72 "	167.4
5 "	243	675	245	685	5259.25	160	17.75	17.75	72 "	168.5
5.05	250	0	250	0	—	170	—	—	—	—

TOTAL KW. DEVELOPED DURING TEST.

Total hours run - - - - - 24
Total K.W. developed - - - - 38325
Average K.W. developed per hour - - 159.6—232.4 H.P. at 92% Eff. of G.
Maximum K.W. developed in one hour - 168.5—245.0 " " "
Average air pressure - - - - - 70 atmospheres
(Oil consumption as shown averages 9.41 Gals. per 100 K.W. hours=6.46 Gals. per 100 B.H.P. hours.)

*Abstract from *The Canadian Engineer*, July 10, 1913.
†Assistant chief engineer, Texas Power & Light Company.

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them has increased to such an extent that a large number of firms, including some of the largest and most reliable, both in America and abroad, are beginning their manufacture.

Up to the present time a considerable amount of information has been published relative to their operation and test, but accurate information as to the results to be accomplished by the use of Diesel engines over extended periods and under the varying conditions of actual practice, is mainly wanting. The Texas Power & Light Co. is at present operating two Diesel oil-engine plants, one at Sherman and the other at Cleburne, and it is the purpose of this article to set forth the actual operating results obtained under every-day operating conditions.

The Sherman plant consists of three 225-hp., 3-cylinder, 4-stroke cycle engines, manufactured by the Busch-Sulzer Bros., Diesel Engine Co., of St. Louis, Missouri, each engine being direct-connected to a 150-kw., 230-volt D.C. generator. These engines were installed January 1, 1905. They weighed about 100,000 lb. and cost approximately $14,000 each.

The official acceptance test is given in the table shown on preceding page.

The oil consumption during the test averages 9.41 gal. per 100 kw-hr., which, with

Diesel Engine—Operating Costs. 450 kw. Installation at Sherman, Texas. Cost of Production.

COST IN MILLS PER K.W.H. HR.

				Maintenance			Operation							
Month	Monthly Output K.W. Hours	K.W. Peak Load*	Load Factor Per Cent.	Engines	Total	Fuel Oil	Labor	Water	Lubricating Oil	All Other	Total	Total Cost Dollars per Month	Total Cost Cents Per K.W. Hr.
1912												$	
March	95,328	—	28.4%	None	—	2.20	2.80	0.02	0.39	—	5.31	—	—
April	77,915	—	24.0%	"	—	2.90	3.46	0.10	0.42	—	6.88	—	—
May	76,820	—	23.0%	"	—	2.50	3.51	0.06	0.63	—	6.70	—	—
June	70,230	—	21.7%	0.09	0.09	2.69	3.83	0.07	0.38	—	6.97	559.43	7.96
July	91,704	—	27.4%	0.03	0.03	2.53	2.94	0.06	0.32	—	5.85	738.20	8.05
August	85,105	—	25.4%	None	—	2.60	3.17	0.06	0.40	—	6.23	808.35	9.50
September	105,506	—	32.5%	0.03	0.03	2.71	2.56	0.08	0.36	—	5.71	621.48	5.83
October	117,360	—	34.7%	None	1.62	2.61	2.30	0.22	—	0.51	5.64	854.13	7.28
November	114,048	—	35.2%	"	0.81	2.46	2.00	0.24	—	0.44	5.14	733.92	6.43
December	117,499	—	35.1%	"	0.37	1.90	2.00	0.31	—	0.36	4.57	551.19	4.69
1913													
January	115,212	—	34.1%	"	0.40	3.00	2.10	0.17	—	0.37	5.64	717.26	6.22
February	101,300	—	33.5%	"	—	2.45	2.22	0.06	—	0.36	5.09	517.12	5.10
Total	1,168,027	—	—	—	—	—	—	—	—	—	—	—	—
Average	97,335	—	29.6%	0.05	0.478	2.54	2.74	0.12	0.40	0.41	5.81	—	6.78

* Total connected load, 1,553 k.w. No reliable record kept of peaks

PHYSICAL DATA.

H.P. Rating of Plant 675. No. of Engines 3. Size each 225 H.P
Cost of Fuel Oil f.o.b. Plant per Bbl. $1.05. Per Gallon .025
B.T.U of Oil 18,000. Average Gal. Fuel Oil per K.W. Hr. .1020
Wages of men per day $9.00. 1 at $3.33. 1 at $2.17. 1 at $2.00. 1 at $1.50

Diesel Engine—Operating Costs. 450 kw. Installation at Cleburne, Texas. Cost of Production.

COST IN MILLS PER K.W. HR

				Maintenance			Operation							
Month	Monthly Output K.W. Hrs.	K.W. Peak Load*	Load Factor Per Cent.	Engines	All Other	Total	Fuel Oil	Labor	Water	Lubricating Oil	All Other	Total	Total Cost Dollars Per Month	Total Cost Cents Per K.W. Hr.
1912													$	
April	67,850	—	20.9%	None	None	—	3.08	4.79	0.40	0.38	0.07	8.72	—	—
May	74,330	—	22.2%	"	"	—	3.29	4.37	0.38	0.64	0.06	8.74	—	—
June	73,410	—	22.7%	0.14	"	0.14	3.19	4.42	0.46	0.50	0.07	8.64	587.57	8.00
July	80,020	—	23.9%	2.33	"	2.23	3.20	4.06	0.44	0.46	0.06	8.22	800.13	10.00
August	86,860	—	24.9%	0.47	"	0.47	3.09	3.74	0.49	0.72	0.06	8.10	650.20	7.48
September	89,130	—	27.5%	0.08	"	0.08	3.14	3.64	0.36	0.32	0.05	7.71	673.18	7.55
October	100,580	—	30.0%	1.32	0.16	1.48	3.03	3.11	0.30	0.43	0.05	6.92	878.55	8.73
November	107,379	—	30.9%	0.22	0.31	0.53	2.99	2.72	0.16	0.42	0.05	6.34	746.31	6.95
December	123,030	—	36.7%	2.03	0.03	2.06	3.03	2.59	0.42	0.38	0.04	6.46	951.53	7.73
1913														
January	127,170	—	37.9%	0.72	0.72	1.44	2.96	2.23	0.72	0.22	0.04	6.17	1102.97	8.67
February	98,430	—	32.5%	1.64	0.01	1.65	3.00	3.20	0.28	0.56	0.05	7.09	1010.52	10.26
March	106,270	—	31.7%	1.30	0.24	1.54	2.98	2.91	0.24	0.30	0.05	6.48	—	—
Total	1,134,459	—	—	—	—	—	—	—	—	—	—	—	—	—
Average	94,538	—	28.8%	1.02	0.24	1.17	3.08	3.47	0.39	0.44	0.05	7.46	—	8.37

* No record of peak loads available

PHYSICAL DATA.

H.P. Rating of Plant 675. Number of Engines 3. Size of each 225 H.P.
Cost of Fuel Oil f.o.b. Plant per Bbl. $1.25 to $1.64. Per Gal. .03 to .039
B.T.U. of Oil 18,000. Ave. Gal. Fuel Oil per K.W. Hr. .1020
Wages of men per day $10.83. 1 at $4.16. 2 at $2.50. 1 at $1.66.

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oil at 25c. per gallon, is equivalent to 2.35c. per kilowatt-hour.

During the year 1910, 862,050 kw-hr. was generated at a total fuel cost of $2695.98, the fuel being the ordinary distillate as obtained from Texas crude oil, and costing $1.30 per barrel of 42 gal., delivered. This oil has the following approximate characteristics:

Gravity, 37. Flash, 160. Fire, 190.

The operating expenses for the year were as follows:

Power plant wages	$3,014.60
Fuel for power	2,695.98
Water for cooling	37.07
Lubricants and waste	526.38
Miscellaneous supplies	63.78
Engine maintenance	411.12
Total	$6,748.53

Thus, for the year 1910, the cost per kilowatt-hour for fuel was 3.1 mills, and the total cost per kilowatt-hour was 7.1 mills. This, while not including interest on the investment, depreciation, or other so-called overhead expenses, is certainly exceptionally low in cost per kilowatt-hour for a plant of this size.

In table II are given the results for the 12 months' period from March 1912 to February 1913. It will be noted that the total cost of production per kilowatt-hour was 6.78 mills with fuel oil at $1.05 per barrel of 42 gallons.

The plant at Cleburne consists of three 225-hp. units similar to those at Sherman, with the exception that each engine is direct connected to a 3-phase, 2300-volt, 60-cycle alternating current generator. It is worthy of note that no trouble whatever has been experienced in paralleling these machines.

In table III are the results of 12 months' operation at this plant.

In conclusion, I wish to state that for small and medium sized plants, I believe the Diesel oil-engine to be the most efficient prime mover available, and while the engine is now built only in comparatively small sized units, there is no doubt in the future it will be developed in large sizes and made available where a large quantity of power is desired. The first cost of the engine is high, and in some cases this may be a drawback.

It is also essential to have a good mechanic as head plant engineer, as the engine requires intelligent handling. They are, however, far from being the trouble-makers internal-combustion engines are supposed to be, and are giving excellent service in both of the plants above mentioned.

Jacket-Water Requirements of Internal-Combustion Engines

By REGINALD TRAUTSCHOLD

TESTS and practice have indicated that a well designed internal-combustion engine operates most economically when its jacket water is discharged at the highest temperature attainable without serious generation of steam in the engine jackets—a temperature of about 185 or 190°F.; also, that the temperature of the jacket-water supply has little effect upon the fuel consumption of the engine, provided a difference of at least 105° is maintained between the temperatures of the incoming and the outgoing water. To maintain a suitable temperature of discharge, then, the quantity of water supplied to the jackets and the temperature at which it is admitted are the two governing conditions.

Considering first the consumption of jacket water, not only does the load on the engine affect the quantity required, but the efficiency of the engine under the load must also be taken into consideration. Considering both fuel and jacket-water requirements as unity at full load, when the engine operates at its best efficiency, the increase in fuel and jacket-water requirements for the best results in a typical case are given in table I, which is graphically shown in Fig. 1. At three-eighths load, about the lighest load that an engine in an efficient installation is called upon to carry, the fuel requirements per horse-power are 54.5% greater than when operating under full load, while the jacket-water requirements are 2.85 times as great as under the more efficient operation. This relation is about constant regardless of the temperature of the water fed to the jackets, provided it is not much

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more than 80°F., above which temperature of supply the generation of steam in the jackets commences to become serious before the efficient temperature ranges of 105° are attained, resulting in reduced jacket efficiency and a corresponding increase in fuel consumption.

TABLE I.—EFFECT OF LOAD ON FUEL AND JACKET-WATER CONSUMPTION.

Load	Consumption per Horse-power.	
	Fuel.	Jacket Water.
Full.	1·000	1·000
7/8	1·048	1·099
3/4	1·108	1·232
5/8	1·200	1·440
1/2	1·325	1·765
3/8	1·545	2·850

The temperature of the water-supply to the jackets has an effect, however, upon the consumption of jacket water, for the cooler the water the longer it can be retained in the jackets, water of a higher temperature reaching the advisable temperature of discharge through a lesser temperature range. The minimum practical temperature of the

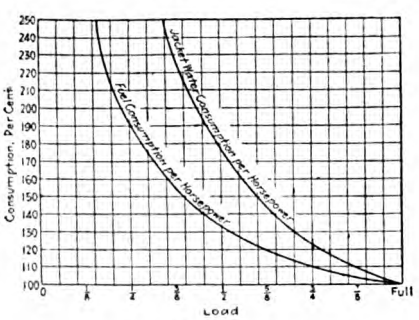

FIG. 1.

jacket-water supply is about 35°F., while its maximum temperature is about 80°. Considering the required quantity of jacket water at an entering temperature of 35° as unity, the quantity of jacket water required at other temperatures of supply and under various engine loads is given in table II. In installations where the jacket water is used over and over, the rate of consumption is of secondary importance, as, within reasonable limits, this simply necessitates increasing or decreasing the mean velocity of the water through the jackets. Where water is sufficiently cheap to permit its being wasted, the supply temperature is usually relatively low, and the saving that accrues from low temperature of supply may or may not be sufficiently great to take into consideration. The former practice, that of cooling the water and using it over again,

TABLE II.—EFFECT OF SUPPLY TEMPERATURE ON JACKET-WATER CONSUMPTION.

Temperature of Water Supply	Quantity of Jacket Water Required at Various Loads.					
	Full	7/8	3/4	5/8	1/2	3/8
F.						
35	1·000	1·135	1·313	1·598	2·041	2·735
40	1·030	1·165	1·343	1·628	2·071	2·765
45	1·067	1·202	1·380	1·665	2·108	2·802
50	1·108	1·243	1·421	1·706	2·149	2·843
55	1·151	1·286	1·464	1·749	2·192	2·886
60	1·198	1·333	1·511	1·796	2·239	2·933
65	1·245	1·379	1·558	1·843	2·286	2·980
70	1·295	1·429	1·609	1·893	2·336	3·030
75	1·353	1·487	1·667	1·951	2·394	3·088
80	1·422	1·556	1·736	2·020	2·463	3·157

is the more common, and, as the rate of consumption is of little importance, the effect of supply temperature on the consumption of jacket water is of interest. Considering the requirements at full load as unity, this relation is graphically shown in Fig. 2, and, although little difference in the

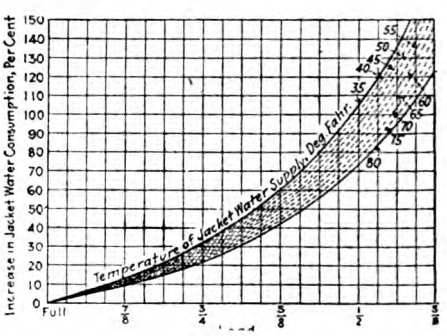

FIG. 2.

requirements of an engine operating under at least seven-eighths load is noticeable, there is considerable variation between one-half and three-eighths load. From full load to three-eighths load the increase in jacket-water consumption, with water supplied at 35°, would be 173.5%, while in the case of jacket water supplied at 80° the increase for the same range in load would be only 122 per cent.

The jacket-water requirements in gallons per horse-power at various loads and supply at temperatures for an efficient oil-engine are indicated in Fig. 3; also, this may be taken as typical of internal-combustion engines operating on any fuel. A fuel low in

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heat value, such as ordinary city gas and producer gas, requires more jacket water for power developed than richer fuels, but the effect of load and jacket-water requirements on fuel consumption is about the

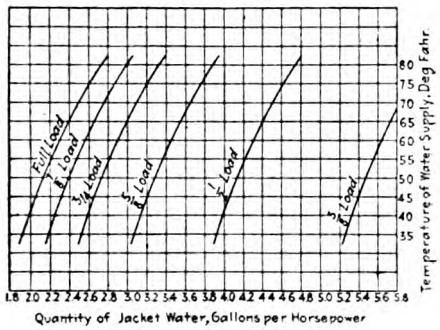

FIG. 3.

same. In any event, the importance of carefully regulating the jacket-water supply to conform with the engine load is evident, for the temperature range of the jacket water is directly dependent upon its supply.

In installations where the cooling jacket water is used repeatedly, there is no appreciable gain in reducing the temperature of the supply to much below 80°F. In fact, at this temperature there is an advantage, other than that of reducing the cooling facilities that must otherwise be provided; for the supply of jacket water when the engine is operating under light load does not have to be relatively increased as much as when the water-supply is cooler, facilitating regulation, or, rather, minimizing losses in efficiency should the regulation not be sufficiently sensitive. In installations where the jacket water is wasted, the supply may be advantageously as near 35° as possible, and thus decrease the consumption, even though the relative increase in jacket-water requirements from full to light loads is greater, and the regulation, therefore, necessarily more sensitive than when using warm water.

Accurate hand regulation of the water-supply to the jackets is naturally difficult, and in many installations automatic regulators can be advantageously installed. The saving in fuel consumption that is possible through the use of such controllers or regulators depends, of course, upon the variations in engine load and upon the attention of the operating engineer to the jacket temperatures without such automatic devices, a fairly constant load, and careful engineers discounting the value of a jacket-water controller as a money saver.—*Power.*

An Outlet Sewer of 24-Inch Corrugated Iron Culvert Pipe at El Paso, Texas*

THE original outlet of the gravity sewage system of El Paso was slightly above the bed of the Rio Grande. In 1898 a cut-off was made to straighten the river channel so that the water of the river at flood stage would not inundate the lower areas of the city. Later the river channel moved to the north and washed away the sewer outlet and about 1000 ft. of the sewer. At the same time the bed of the river rose so that the old outlet was nearly 2 ft. below the new river bed. To prevent backing up of the sewage, especially at the flood stage of the river, pumps were installed at the last manhole on the sewer line and the sewage was pumped into the river above the highest water. Previous to 1912 a sewage-disposal plant was built and the sewage was brought to it. This plant was a failure.

In 1912 the Rio Grande shifted from its channel near the disposal plant to a distance of 4000 ft. in 24 hours and is likely to return in the same time. It was necessary to pump crude sewage from the treatment plant to the new outlet. In order to carry the sewage by gravity it was necessary to build the pipe-line on a terroplane from 2 to 4 ft. above the general level of the ground to be traversed. The problem then became one of finding a pipe that would stand in light soil (light silt) subject to the constant menace of overflow, and which could be moved and saved in case the river changed back to its old channel. On account of the location of the international boundary and the laws governing permanent works in channels, the outlet could not be protected.

*Abstract from *Engineering and Contracting*, August 6, 1913.

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The 16-gauge, 24-in., American ingot galvanized iron culvert pipe was finally selected for this service. Sewage is pumped into the upper end of this pipe which is about 130 ft. from the treatment works. The pipe cost, installed, about $1.45 per lineal foot. Vitrified clay or concrete pipe would have cost about $1.60 per foot installed and could not have been quickly removed in an emergency.

This pipe was installed in 30-ft. lengths, in July 1912. Band connections were used because of the ease of installation and to facilitate removal of the pipe in an emergency. About the first of August the sewage was turned into this pipe-line. There was a slight leakage at the connections, but this was overcome by the use of wheat bran. No leakage has since been noted. Although a few joints were asphalted at the time the pipe was installed, it was found afterward that this was not necessary.

Seven months after installation, Herbert Nunn, city engineer, to whom we are indebted for the information here given, reported that although the pipe had been carrying about 3,000,000 gal. of crude, highly concentrated, and septic sewage per 24 hr., the galvanizing was not at that time tarnished. At that time the pipe seemed as good as new. In a recent letter to the editors, however, Mr. Nunn states that a recent examination showed that most of the galvanizing has been removed and that a slight pitting is taking place in the iron.

F. H. Todd, consulting engineer of El Paso, made some tests on the carrying capacity of the pipe in December 1912. He concluded that for velocities approximating 1½ ft. per second in 24-in. (least diameter) corrugated pipe, the value of n in Kutter's formula is between 0.0212 and 0.0222.

TABLE 1.—CONCRETE CHANNELS—VALUES OF KUTTER'S COEFFICIENT "N" FROM EXPERIMENTS.

Ref. No.	Q	R.	V.	C.	N.	Length feet	Alignment	Condition of Surface, Etc.
					UMATILLA PROJECT (Circular Section; 4.9 ft. radius.)			
1	205	2.13	7.10	129	.0132	640	Tangent	Concrete built with forms; not trowelled.
2	205	2.17	6.86	114	.0149	120	100 ft. Radius....	
3	205	2.15	6.94	90	.0189	220	50 ft. Radius.....	
4	205	2.12	7.15	149	.0142	1075	Slight curve.....	
					UMATILLA PROJECT (Trapezoidal Section; 1¼ to 1 side slopes; bottom width 1.5 feet.)			
5	5.7	0.58	2.06	102	.013	932	Slight curve.....	Smooth and regular.
					BOISE PROJECT (Trapezoidal Section; 1½ to 1 side slopes; bottom width 40 feet.)			
6	1011	4.89	3.34	135	.0142	1000	Tangent	Rough trowelled No. 6 had considerable rock and stone in bottom; others had small quantities of gravel and stone in bottom.
7	316	2.14	3.08	121	.0140	1000	..do.....	
8	1027	3.88	4.68	121	.0154	1000	..do.....	
9	476	2.64	3.57	115	.0152	1000	..do.....	
10	245	1.95	2.64	111	.0149	1000	..do.....	
11	119	1.44	1.84	91	.0170	1000	..do.....	
12	1209	4.22	4.91	135	.0139	1000	..do.....	
13	1011	4.33	3.90	116	.0164	2400		Much gravel in bottom.
14	470	2.45	3.81	133	.0130	2400		Small quantity of gravel in bottom.
15	470	2.65	3.48	136	.0129	2400		
16	238	1.87	2.67	113	.0147	2400		
17	238	2.09	2.35	114	.0148	2400		
18	1027	3.64	5.00	148	.0124	2400	Number of short curves	Similar to No. 6 to No. 17. Concrete trowelled to smoother surface.
19	456	2.89	2.98	145	.0123	2400		
					BOISE PROJECT, (Trapezoidal Section; 1½ to 1 side slopes; bottom width 10 feet.)			
20	50	1.30	2.45	119	.0132	1000 to 2400	Numerous curves	Very smoothly trowelled. Some gravel on bottom.
21	103	2.13	2.32	130	.0130		....do.....	
22	230	2.73	3.35	145	.0122		....do.....	
23	382	3.29	3.99	147	.0124		....do.....	Short selected sections nearly free from gravel. Very smoothly trowelled.
24	50	1.30	2.43	123	.0127		....do.....	
25	103	2.06	2.45	129	.0131		....do.....	
26	230	2.72	3.37	158	.0112		...do.....	
27	382	3.24	4.08	141	.0118		....do.....	Some gravel on bottom. Very smoothly trowelled.
28	376	3.11	4.32	142	.0126		...do.....	
29	318	2.90	4.15	138	.0129		....do.....	
30	59	1.37	2.60	130	0122		...do.....	
					YAKIMA PROJECT, SUNNYSIDE UNIT (Circular Section, 4 ft. radius.)			
31	52.5	0.69	12.42	104	.0136	900	Short 2° curve....	Concrete built with wooden forms. No retouching of surfaces.
32	247	1.37	19.30	114	.0140	900	.....do.....	
33	242	1.36	19.13	114	.0140	900	.....do.....	
34	52.5	0.67	13.07	133	.0109	1300	Tangent	
35	247	1.33	20.44	148	.0110	1300	..do.....	
36	242	1.30	20.62	150	.0108	1300	..do.....	
37	45	0.62	12.52	132	.0109	1300	..do.....	

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Experimental Values of Kutter's Coefficient 'N' for Open Channels*

Data have been received from a number of projects bearing on the values of *n* for concrete-lined and earth canals as obtained from observations made in the field. These have been arranged in the accompanying tables, containing the essential factors for each observation, for the information of those having to do with the design of open

TABLE 2.—EARTH CANALS—VALUES OF KUTTER'S COEFFICIENT "N" FROM EXPERIMENTS.

Note—Side slopes of all sections 1½ to 1.

Ref. No.	Q.	R.	V.	C.	N.	Length	Condition of Surface, Etc.
					NORTH PLATTE PROJECT.		
1	1164	6.16	2.84	110	.0185	5280	Sandy; fair condition; erodes; some brush riprap.
2	1154	5.94	2.89	110	.0183	5280	do
3	1176	6.17	2.86	106	.0193	5280	do
4	1170	6.05	2.86	87	.0235	5280	do
5	1085	5.66	2.89	107	.0188	5280	Gravelly; good condition.
6	1075	5.82	2.81	128	.0158	5280	do do
7	1075	6.08	2.72	103	.0197	5280	do do
8	1075	6.18	2.59	99	.0207	5280	Gravelly to light; poor condition.
9	1075	6.36	2.47	76	.0274	5280	Light soil; bad condition.
10	1075	6.18	2.61	101	.0203	5280	Light and sandy; bad condition.
11	1137	5.79	2.92	108	.0187	5280	
12	1130	5.96	2.84	129	.0157	5280	
13	1130	6.21	2.77	100	.0204	5280	
14	1130	6.30	2.64	101	.0204	5280	
15	1130	6.46	2.53	75	.0280	5280	
16	1130	6.28	2.68	108	.0190	5280	
17	1057	5.58	3.13	110	.0181	5280	Gravelly; fair condition.
18	1056	5.64	2.87	103	.0194	5280	Sandy; fair condition.
19	1052	5.70	2.83	103	.0195	5280	Sandy; good condition.
20	1096	5.75	3.09	103	.0194	5280	
21	1094	5.81	2.84	101	.0199	5280	
22	1089	5.86	2.82	96	.0210	5280	
23	1194	6.01	2.94	124	.0164	10560	No. 11 and No. 12 combined.
24	1182	6.33	2.72	99	.0208	5280	Same as 13.
25	1180	6.23	2.75	104	.0197	5280	do 14.
26	1178	6.36	2.71	87	.0238	5280	do 15.
27	1176	6.55	2.69	117	.0178	5280	do 16.
28	1163	5.99	3.17	103	.0196	5280	
29	1161	6.02	3.03	97	.0209	5280	
30	1148	5.69	3.00	116	.0174	5280	
31	1140	5.78	2.97	125	.0160	5280	Same as 23.
32	1132	6.08	2.75	101	.0204	5280	do 24.
33	1130	6.10	2.75	112	.0183	5280	do 25.
34	1128	6.33	2.71	85	.0244	5280	do 26.
35	1126	6.44	2.69	114	.0181	5280	do 27.
36	1140	5.69	3.28	126	.0158	5280	
37	1132	5.58	3.32	114	.0175	5280	Same as 17.
38	1125	5.59	3.22	111	.0180	5280	do 19.
39	28.76	1.17	2.33	73	.0203	2000	
40	27.02	1.11	2.22	69	.0210	2000	
41	21.98	1.05	2.20	73	.0197	2000	
42	21.94	1.03	2.09	70	.0204	2000	Even numbers are on same reach.
43	9.98	0.75	1.68	67	.0199	2000	Odd numbers are on same reach.
44	10.27	0.73	1.71	66	.0201	2000	
45	20.04	1.02	2.13	71	.0201	2000	
46	20.09	0.97	2.08	70	.0203	2000	
47	13.56	0.82	2.09	91	.0155	2000	
48	11.57	0.73	2.21	82	.0166	2000	
49	24.30	1.10	2.25	83	.0177	2000	Even numbers are on same reach.
50	22.30	1.00	2.54	82	.0176	2000	Odd numbers are on same reach.
51	31.40	1.24	2.39	82	.0183	2000	
52	28.31	1.13	2.57	80	.0185	2000	
53	64.9	1.60	2.13	90	.0177	1600	
54	64.9	1.67	2.04	102	.0157	1400	
55	147	2.31	2.60	96	.0179	1600	
56	147	2.31	2.59	95	.0179	1400	
57	148	2.32	2.57	99	.0172	1600	Even numbers are on same reach.
58	148	2.33	2.50	90	.0188	1400	Odd numbers are on same reach.
59	167	2.40	2.62	99	.0172	1600	
60	167	2.39	2.61	92	.0187	1400	
61	173	2.41	2.67	98	.0175	1600	
62	173	2.41	2.67	93	.0185	1400	
63	49.9	1.42	2.02	83	.0187	1000	
64	54.5	1.49	2.05	76	.0204	1000	
65	73.3	1.70	2.29	94	.0172	1000	Observations 63 to 68 on same reach.
66	83.1	1.85	2.31	85	.0192	1000	
67	102	2.08	2.39	82	.0203	1000	
68	120	2.23	2.55	92	.0182	1000	
69	49.9	1.55	1.84	74	.0211	1000	
70	54.5	1.61	1.91	77	.0203	1000	
71	73.3	1.83	2.11	74	.0217	1000	
72	83.1	1.95	2.18	74	.0219	1000	
73	102	2.16	2.29	72	.0231	1000	
74	120	2.33	2.41	74	.0220	1000	

*Abstract from *Reclamation Record*, July 1913.

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(Table 2 Continued)

No	Q.	R.	V.	C.	N.	Length	Condition of Surface, Etc.
					TRUCKEE-CARSON PROJECT.		
75	13.14	0.68	1.51	116	.013	100	Straight banks; bottom firm, smooth, slick.
76	13.93	0.84	1.33	100	.014	100	Coarse, sandy soil; banks good.
77	14.95	0.78	1.38	89	.0157	100	Coarse, sandy soil; banks good.
78	19.71	0.86	1.44	82	.0167	100	Some brush; bottom sandy in ridges.
79	18.08	1.16	1.27	80	.0181	100	Silted, firm, gravelly bottom; some weeds.
80	19.82	1.41	0.92	83	.0179	100	Slick mud over sand; no weeds.
81	20.18	0.87	1.41	77	.018	100	Bottom muddy and sandy.
82	23.60	1.13	1.10	75	.019	100	Straight, firm; coarse sand bottom.
83	20.00	1.06	1.22	75	.0202	100	Bottom sandy and ridged.
84	205.60	3.18	2.14	89	.0202	100	Sand and white clay.
85	150.06	2.63	1.48	83	.0201	100	Bottom firm and hard; banks loose.
86	20.16	1.63	1.24	75	.0208	100	Banks firm; bottom firm and sandy.
87	154.55	2.53	1.47	89	.0209	100	Banks loose; bottom firm and hard.
88	230.81	3.66	1.67	84	.0222	100	Firm, coarse gravel; large boulders on sides and bottom.
89	354.93	3.94	2.24	76	.0254	100	Hard soil; bottom washed.
90	135.18	2.06	1.55	63	.0259	100	Brush riprap on one side; bottom sandy.
91	50.68	1.60	1.51	59	.0260	100	Coarse, shifting sand on bottom; heavy grass on bank.
92	122.49	2.06	1.50	61	.0261	100	
93	139.58	2.16	1.59	64	.0277	100	Brush on both sides; sandy ridges on bottom.
94	423.05	3.77	2.12	69	.0280	100	Bottom sandy in ridges.
95	301.81	3.94	2.03	62	.0306	100	Firm, coarse sand; many large boulders.
96	314.01	4.19	2.10	55	.0346	100	½ concrete, ½ rock; very rough.
					BOISE PROJECT.		
97	18.11	0.74	1.71	48	.0264	200 to 600 feet	Bottom rather rough; hardpan gravel and sand; some weeds.
98	2.40	0.30	0.97	45	.0224		
99	7.42	0.68	1.23	48	.0260		Bottom hardpan and gravel; weeds hanging into water.
100	3.11	0.42	1.25	50	.0224		
101	4.26	0.52	1.16	52	.0225		Bottom sand and silt; no weeds.
102	1.79	0.34	1.04	42	.0244		Bottom hardpan, gravel and mud; some weeds touching water.
103	3.50	0.44	0.87	36	.0293		Bottom rather rough hardpan.
104	2.10	0.56	0.44	44	.0251		Bottom smooth; muddy banks lined with weeds which hang into water.
105	58.24	2.07	1.18	57	.0286		Bottom sand and silt; banks overhang and are covered with grass.
106	46.21	1.60	1.60	61	.0254		Bottom rough; weeds on banks and in bottom.
107	1027.37	3.80	3.22	88	.0211		Clay and hardpan in good order; no weeds.
108	11.18	0.84	0.79	54	.0242		Black loam; some moss and weeds.
109	23.26	1.06	1.96	54	.0258		Sandy bottom; some weeds.
110	2.80	0.36	0.96	58	.0190		Very slick, black volcanic ash.
111	2.22	0.33	0.88	42	.0240		Fine grained sand; no weeds.
					SALT RIVER PROJECT.		
128	177	2.15	2.47	86	.0194	5000	Observation 128 to 145 made on same reach. Cross sections uniform with fibre roots on side slopes holding silt deposits. Bottom was the original cement gravel with sprinkle of clean sand in pockets.
129	181	2.21	2.43	84	.0201	5000	
130	222	2.39	2.71	90	.0191	5000	
131	230	2.38	2.85	96	.0179	5000	
132	220	2.38	2.72	91	.0187	5000	
133	230	2.39	2.74	83	.0190	5000	
134	220	2.39	2.62	79	.0200	5000	
135	230	2.40	2.65	86	.0198	5000	
136	220	2.40	2.53	82	.0207	5000	
137	176	2.06	2.48	89	.0186	5000	
138	167	2.06	2.36	85	.0194	5000	
139	176	2.07	2.57	91	.0186	5000	
140	167	2.07	2.44	87	.0193	5000	
141	176	2.07	2.56	90	.0179	5000	
142	167	2.07	2.52	89	.0188	5000	
143	141	1.87	2.32	87	.0190	5000	
144	146	1.92	2.33	86	.0193	5000	
145	500	3.75	3.06	82	.0229	5000	
150	151	1.98	1.95	70	.0230	5000	Observations 150 to 163 made on same reach. Side slopes were of silt with practically no vegetation. The bottom was covered to a depth of about one foot with clean, sharp sand, which under action of flowing water was formed into dunes about 0.8-foot high at right angles with the direction of flow. The dunes were about 8 feet apart and travelled with the current at the rate of about 2 or 3 feet per hour.
151	151	1.98	1.92	70	.0232	5000	
152	151	1.98	1.90	70	.0234	5000	
153	162	1.98	1.96	72	.0228	5000	
154	155	2.06	1.88	66	.0249	5000	
155	162	2.06	1.94	68	.0238	5000	
156	155	2.08	1.86	66	.0250	5000	
157	162	2.08	1.92	68	.0240	5000	
158	155	2.09	1.86	66	.0250	5000	
159	152	1.98	1.92	68	.0233	5000	
160	128	1.77	1.86	71	.0224	5000	
161	121	1.77	1.76	67	.0230	5000	
162	555	4.07	2.69	69	.0274	5000	
163	530	4.05	2.61	67	.0276	5000	

channels made of various materials.

The nature of the data does not justify the formulation of general conclusions as to the proper value of n to be used for different materials, but the values heretofore generally used namely, 0.012 to 0.014 for concrete and 0.020 to 0.025 for earth channels, seem to be substantiated.

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Regulation of Public Utilities in Wisconsin *

By HALFORD ERICKSON

WITH respect to rates, our experience varies. In many cases the rates have been found to be unreasonably high as well as unjustly discriminatory. In other instances again, though less frequently, the rates have been found to be unreasonably low. Rates that are thus too high and that under similar conditions are higher for some persons and localities than for others are harmful and against public policy. They result in unequal distribution of wealth. They mean that money is unjustly transferred from one set of pockets to another set of pockets, and that a few are enriched at the expense of the many. They retard industrial development and commercial growth, and, in the same line of business, tend to build up some at the expense of others. They also lead to results that are bad, from a rural and ethical point of view.

Rates that are too low may also be harmful. They usually stand for poor equipment and poor service. When so low as not to provide means for the proper upkeep of the plant they may even lead to the entire ruin or loss of the service. Instances where conditions of this kind prevail are met with from time to time. They are detrimental not only to those who are directly affected, but to the public as a whole. Losses from poor service may be as great as losses from rates that are too high or discriminatory.

The law provides that the rates must be reasonable. The courts have held, in substance, that under normal conditions of a plant when taken as a whole, the rates in order to be reasonable should be high enough so that the revenues therefrom are sufficient to cover reasonable amounts for the operating expenses of a plant, including depreciation thereon and interest and profit on the fair value of the property used and useful for the convenience of the public.

The sum of the operating expenses and fixed charges is thus made the legal basis for rates. The first problem of the rate-maker, therefore, consists of determining what constitutes reasonable amounts for these expenses and charges.

The first step that is necessary in the determination of such rates is to find the fair value of the property upon which the investors are entitled to interest and profit. In this determination one is at the very outset met with conflicting opinions of all kinds, not only as to what should be included in the term 'property,' but as to what is meant by 'fair value.' Some insist that the term 'property' includes only the physical property that is used and useful in serving the public. Others again hold that besides the physical property it also includes the cost of developing the business. There are some who argue that the fair value is represented by the original cost, and others again that it is represented by the cost of reproduction at the time of the appraisal. A careful analysis of the facts indicates that the cost of both the physical property and of the business should be included in the appraisal, and that the original cost, as well as the cost of reproduction, not only of the physical property, but of the business as well, constitute evidence of value.

The original cost of the physical property includes the cost of all the land, labor, material, and equipment of all kinds that are required in order to obtain a complete plant ready for operation. It also covers such overhead charges in connection therewith as organization, legal expenses, engineering and superintendence of construction, insurance and contingencies of all kinds, interest during construction period on the capital used, etc. When a plant is needed and cannot be had on better terms, the original cost may also have to include something for discounts on bonds and for promoters' expenses. In fact, the original cost of the physical property should include all necessary expenditures that were judiciously made in obtaining the plant. Before it can be effectively and economically operated, such a plant must also be provided with a working capital.

The true original cost is difficult to determine. One reason for this is that the records are too often either defective or missing. Another reason is that, even when in existence, these records contain so many irrelevant items that it is hard to pick out

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from the whole mass those which are material. Thus, it is often found that construction is charged with outlays which belong in the operating and depreciation accounts. Heavy charges are sometimes also made to construction for franchises and good-will values as well as for estimated future increases in values and for other reasons. To unearth the actual cost from such a conglomeration of charges as these is sometimes impossible. The probable and reasonable cost, however, is not made inaccessible by this fact, for many items can be closely estimated from the facts obtained from examinations of the present plant, its design, location, growth, character, size, the prices of labor, material, and other elements which prevailed when built, and comparisons with similar plants of which the cost is known. Thus in the end a very close approximation of the actual cost of the physical property of the plant can ordinarily be obtained.

The next measure of value is obtained by determining what it would cost to reproduce the plant rather than by what the plant actually cost. In thus determining the cost of reproduction, new, of the plant, it is necessary to obtain complete inventories of every element that enters into such cost, as well as detailed statements of the prices at which these elements can be had, installed, and shaped into an operating plant. The prices so used are the results of most careful and extended studies and compilations of market quotations and of prices at which sales were actually made. In order to avoid the abnormal effects of sudden fluctuations in such prices, and to obtain results that are more nearly normal, the prices chosen may be said to represent average conditions for a considerable period, rather than the prices as of any particular date. When the elements which are thus included in the cost cover such overhead expenses as those incurred for organization, for legal and engineering service, for superintendents of construction, for interest and the capital used in construction, for insurance and contingencies, then this cost would seem to fairly represent what the plant would actually have cost. In this case, the same as in determining the original cost, it may be necessary at times also to consider certain bond discounts and promotion expenses in arriving at the probable total cost of reproducing the plant.

Neither the original nor the reproduction cost new of a plant is a fair measure of its present cost value unless the depreciation that has taken place in the plant has been provided for and goes with the plant. Depreciation is a natural and inevitable loss of efficiency and value that takes place in practically all parts of public utility property, except perhaps land. It is caused by wear, tear, and general decay; by inadequacy resulting from the failure of machinery and other parts to adequately meet increasing demands upon the plant; and by obsolescence or through the inventions and discoveries of new machinery and methods by which existing equipment has to be superseded. All of these causes are often at work in the same plant, and the amount by which the property has thus been lowered in value by such depreciation at the time of the appraisal should be deducted from both the original cost and the cost of reproduction, new, of the physical property and plant. The result of this is that both the original cost and cost of reproduction new are in a sense brought down to date and that the respective present cost values of the plant under both methods is obtained. The present values as thus obtained, even when the one is greater than the other, furnish good evidence as to the present fair value of the physical property.

When the value of the physical property of the corporation has finally been determined, there remains still another cost which often is legitimately a part of the investment on which reasonable returns should be permitted. This is the cost of developing a paying business. The most perfectly equipped utility plant in existence is useless if it has no customers. The acquisition of customers is a costly process. It involves not only the expense of advertising, solicitation, free experimental service, and other actual outlays, but it may include the entire amount by which the plant, during the first few years of its operation, fails to pay operating expenses and a reasonable return on the investment. This latter amount may be to some extent offset by exorbitant profits after the plant reaches a paying basis, or by the fact that failures to earn a return may be in part due to poor management or lack of ordinary business judgment. But when all deductions have been made for such circumstances, there will usually be found, at least for some utilities, a steadily decreasing deficit for the first few years, which is fairly chargeable to the cost of developing a paying business.

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This deficit, being a large part of the cost of a successful public utility plant, is, as a rule, properly added to the present cost value of the property. It is sometimes termed 'going value,' but is more properly the cost of building up the business.

Just as in the case of the physical property of the corporation, the cost of building up the business may be ascertained by finding what it would cost under present conditions to reproduce the present business. This is done by determining from all the available data as to the amount and density of population, familiarity of the people with the use of the service in question, etc., what time would be required for a new plant to build up a paying business. The operating expenses and revenues during such period being capable of estimation, the total deficit for the period may be taken as the cost of reproduction of the business of the plant. This reproduction cost and the actual original cost of the business can then be compared, and the determination of the going value or cost of the business then depends upon the exercise of a sound judgment, based upon these two costs.

The original cost and the cost of reproduction of the plant and of its business ordinarily constitute the best evidence as to what constitutes the fair value of the property. In some instances these two costs are far apart, but in most cases they seem to approach each other quite closely. When far apart, the difference is mostly due to variations in the general price level of the elements which enter into the construction of the plant and the development of its business as between the time when the plant was first built and the time of the reproduction, although contingencies, mistakes of judgment, and errors of various kinds may play important parts. The tendency today, in appraisals, seems to be to attach greater importance to the cost of reproduction than to the original cost. As to which of these factors is the most important is a matter that is greatly dependent on conditions.

When the fair value of all the property that is used and useful has thus been determined, the question arises as to what constitutes reasonable amounts for interest and profit on this value, as well as for depreciation and other operating expenses. These outlays, as stated above, may be said to make up the total cost of the service.

The returns to be allowed to the investor usually consists of two elements: the ordinary rate of interest for the use of his money, and a compensation for the risk he has undergone. Both of these items vary with differences in time and conditions. Bare interest, or compensation for the use of money, is largely a question of market rates, and is determinable by a study of the investment market generally, of local conditions. The second element, or the profit to be returned to the investor as a compensation for his risk, and, to a certain extent, for the business ability and management required to look after the investment, is the resultant of many conditions, such as the location of the plant, the prospects of the municipality or region in which it is situated, the circumstances tending to make operating costs high or low, and numerous other factors. Generally speaking, the risk is greater in a new than in an established enterprise. All of these matters when taken together indicate how far the investor is entitled to a return above ordinary interest for the mere use of his money. The best results are secured by fixing rates of return that will cause an unobstructed flow of capital into the public utility field.

Depreciation also is an element in the cost of the service and must therefore be covered by the rates charged for such services. That this is the case is quite obvious, not only from the nature of the depreciation, but from ordinary business conditions. Depreciation is incurred because of the service and must therefore, like the other costs of this service, be borne by the takers. Unless it is so borne it would not be possible to obtain capital at such rates of interest as those which are accepted when it is understood that the property is to be kept up.

The operating expenses of the plants also must be audited, examined, and carefully analyzed. The reason for this is that only amounts that are reasonable and necessary under the circumstances should be included in the expenses upon which rates are based. These examinations cannot safely be limited to the expenses alone, but must frequently be so extended as to cover all other records of a plant, its methods of operation, the efficiency of its management, and many other factors.

When the total cost of the service has been determined, it is necessary to so classify and apportion the various items therein that proper costs per unit can be ob-

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tained. Such unit costs are one of the requisites for scientific rate-making.

The first apportionments in this connection consist of the allocations of the various groups which make up the total cost in accordance with their nature or the factors upon which they depend. That is, those parts of the expenses which depend on the number of consumers should be classed as consumer expenses. Those items again which depend upon the capacity of the plant or upon the demand for service, should be placed under capacity or demand expenses. Items of cost which depend on the output of the plant and which vary with such output should be classed as output expenses.

The next step consists in properly apportioning each of these three classes of expenses between the various departments of the service. That is, the total consumer expense should be borne by each department in proportion to their respective number of customers. Likewise, the demand expenses should be allotted to each department in proportion to their respective demands, mostly at the time of the peak load. In the same way, the output expenses should be distributed in accordance with the output for each department. The respective consumer, demand, and output cost for each department must in turn be distributed over each class of service therein, in proportion to the number of consumers, the demand and the output for each of these classes. The final result will then show, for each class of the customers, the proper cost per unit of each of the three classes of expenses named. Apportionments of this kind are not, as a rule, carried down to each customer or beyond each class of customer. The reason for this is that it is usually possible to so classify the customers that the same unit cost or rate apply to each. In other words, the unit costs for each class can ordinarily be made the basis for the rates of that class. These methods apply particularly to electric, gas, and water companies. These separations of the expenses involve complete demand, output, and consumer data for each department and for each class of service, as well as accurate and comprehensive operating and traffic statistics generally. In cases of joint operation, it also means a separation of the common expenses between the utilities involved. In addition to this, it is often necessary to study transmission losses, the saturation of the territory, the nature of the uses to which the service is put, whether the service is metered or not, wastes and losses of all kinds, the adequacy of the service, and numerous other facts and conditions. In this way unit costs are developed which become proper and safe bases for rates.

In the railway service, the expenses and fixed charges are first apportioned between passenger and freight traffic. When the total cost of the freight traffic has thus been ascertained, it is further apportioned as between the cost of handling the freight at the stations and the cost of moving it between stations. The latter apportionments are necessary because the terminal cost depends on the number of tons handled, while the movement cost depends on the length of the haul. With these costs, together with other necessary operating and traffic statistics at hand, it is possible to determine, for the average loading per car, the gross and net cost per ton of the terminal expenses and the gross and net cost per ton per mile of haul of the movement expenses. These costs per unit under average loading are further modified by the effect upon these costs of the respective loadings per car, by the effect of the weight that is and should be given to the value of the articles in rate-making, and by the effect of such differences in the cost as are usually found between local and through transportation; the figures or unit costs so obtained are certain to be of the greatest aid in establishing just and reasonable rates. In fact, these figures are indispensable in rate-making, even in cases where they may have to be further modified because of competitive and commercial conditions.

The loading per car greatly effects the cost per unit of transportation. One reason for this is that switching and other terminal expenses per car are about as great for a car that is lightly loaded as for a car that carries a heavy load. Another reason is that in moving the freight between the stations the cost per ton is as great for the car itself as for the freight in the car, and that in light loading this cost of moving the car alone must be borne by a smaller quantity of articles or pay freight, while under heavy loading this cost per car alone is distributed over larger quantities of articles. Owing to these facts, the net costs per unit are often several times as great under light as under heavy loading, and makes a change in rates justifiable.

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Company Reports

The Southern Counties Gas Co. has applied to the California Railroad Commission for permission to issue $100,000 in 30-year 6% bonds. The company desires to expend $100,367.70 in permanent improvements, of which $44,177.50 is for betterments at the plant, and $56,190.20 for extensions of pipes. The statement of business for the first six months of this year is as below:

Six months ended June 30, 1913.	
Gross income	$113,958.44
Operating expenses, taxes, and depreciation	73,352.08
Net operating income	$ 34,606.36
Less interest, etc	18,738.71
Balance	$ 15,867.65
Less income credited to year ending December 31	5,084.00
Net profit six months	$ 10,783.65

The balance-sheet shows:

Assets:	
Intangible assets	$ 753,527.85
Tangible, plant, etc	703,378.73
Cash and sinking fund	10,367.17
Current assets	44,622.29
Discount on securities	80,618.36
Total	$1,529,514.40
Liabilities:	
Common stock	$ 840,000.00
Preferred	340,000.00
Bonds	580,000.00
Current liabilities	95,180.32
Reserve for depreciation	59,759.31
Surplus after dividends	8,574.77
Total	$1,592,514.40

The Spokane International Railway Co., operated in Idaho and Washington, has reported net earnings amounting to $298,203.33 in 1912, while the net earnings for Idaho alone during the same year were $249,233.24. The following table speaks for itself:

	Receipts.	Expenses.
1908	$ 641,414.85	$464,662,56
1909	701,509.03	483,535.05
1910	1,008,785.03	606,178.07
1911	973,767.13	617,208.22
1912	866,868.55	568,665.22

The following comparison of the net earnings of the company in 1912 with those of 1911 for the entire system, as well as for Idaho, is made in the following table:

Idaho division:	
Net earnings, 1911	$309,242.00
Net earnings, 1912	249,233.24
Entire system:	
Net earnings, 1911	356,558.91
Net earnings, 1912	298,203.33
Idaho expenses and receipts, 1912:	
Gross receipts	$693,033.46
Gross expenses	443,700.22

Central California Gas Co. has reported for July an increase in gross from $3842 to $5274. Operating expenses for July 1913 were $2335, against $1832 last year, leaving net earnings of $2308 as against $1652 last year. For the twelve months ended July 31, 1913, the company earned $53,315, with a net of $30,513 after deduction of $22,802 for operation.

San Joaquin Light & Power Corporation has reported as follows:

Six months ended June 30, 1913.	
Gross earnings	$831,802.37
Operating expenses, maintenance, and taxes	342,956.32
Net income	$488,846.05
Interest charges	203,411.79
Balance	$285,434.26

The Geary Street Municipal Railway, of San Francisco, has earned a net profit of $19,363.74 for the seven months from December 28, 1912, to July 31, 1913.

Income statement for the seven months ended July 31, 1913:

Revenues	$181,760.45
Actual expenses	92,749.27
Gross operating profit	$ 89,011.18
Deduct depreciation sinking fund, being 18% of passenger revenues	32,679.65
	$ 56,331.53
Deduct interest on bonds	36,967.79
Net profit, 7 months ended July 31, 1913	$ 19,363.74

From December 28, 1912, to June 24, 1913, the road was operated, but only to a partial extent, between Kearny street and Thirty-third avenue.

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Hints on Practice

Practical Hints on the Management of Small Oil-Engines*

By P. J. HALER and H. T. WRIGHT

Those interested in the running of oil-engines will have noted the total absence of abnormal sounds when the engine is running smoothly, but will remember the anxiety experienced when a knock is heard in some part of the engine. It is important to be able to find out what is wrong and to put things right immediately. Knock can arise from two distinct causes: (1) a wearing of the moving parts or slackness in some of the connections, and (2) a lack of proper adjustment of supplementary air and water admission valves. There should be little difficulty in distinguishing these two kinds of knock, as the first type has a distinct metallic ring about it, and can generally be localized at once. To do this, stop the engine, turn the fly-wheel round until the suction stroke is completed, then watch the big end, and as it enters the compression stroke, slackness in the gudgeon pin or big end brasses will cause it to slip back slightly in the opposite direction to rotation. Should this part appear to be satisfactory, try the key in the fly-wheel, as this may require drawing in, especially in engines that are new and have run for only short periods. The second type of knock is quite unlike the first, sounding like a dull thud, and the only time when there is at all a likelihood of not being able to distinguish them is when both types occur together. This has happened at various times to us. The dull thud which arises from a lack of adjustment of the water valve is specially noticed when lack of care in starting up has allowed the vaporizer to get too hot. The method of start-

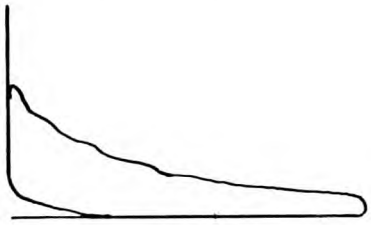

FIG. 1.

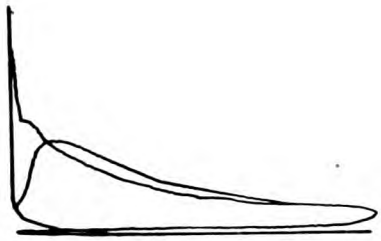

FIG. 2.

FIG. 3.

FIG. 4.

FIG. 5.

FIG. 6.

FIG. 7.

FIG. 8.

*Abstract from *Mechanical World*, June 6, 1913.

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ing the engine is as follows: Make the vaporizer hot, put the cam on half compression, and open the petroleum-admission valve. On the suction stroke air is drawn in and petroleum passes through the holes on the seat of the valve, mixing with the incoming air. After the engine reaches its correct speed and gradually takes up its load, a dull metallic ring is heard in the cylinder, and this we recognize as due to want of water injection. It is advisable to remember that this water injection has various uses. Water vapor mixing with the vaporized oil forms a mixture of high specific heat, reduces the danger of pre-ignition, allows higher compression pressures to be used, and assists in preventing the formation of carbon in the cylinder. The proper working of the engine depends on the water injection being correctly made. To illustrate this, a number of indicator diagrams were taken with a 120 spring, and under the same load. Fig. 1 and 2 show cards taken from the engine after it had just been started and while it was still knocking. On examining the card, the high initial pressure is noted, in one case reaching 230 lb. per square inch, and pre-ignition took place directly after the card was taken. The valve was then opened enough to cause the knocking to die down, and Fig. 3 and 4 show normal diagrams with the engine running normally, but slightly more water being admitted for No. 4. It will be noted that the pressure is falling, but if a tracing of 3 and 4 be placed on 1 and 2 it will be seen that the only alteration in the cards is the loss of the dangerous high initial pressures, these now ranging from 160 to 140 lb. per square inch. In the next series, Fig. 5 to 7, more and more water is added, the initial pressure dropping from 120 to 90 lb. per square inch, while the last card, Fig. 8, simply shows a slow burning, a small quantity of water and petroleum escaping past the piston in the latter case. The diagrams show the necessity for careful adjustment; if an indicator is not available, note should be made of the exhaust, as a wet and steamy exhaust indicates too much water. If a very light oil is supplied, the engine will not run smoothly with the same amount of compression, and no adjustment of tne water valve will stop the loud sound of the explosion. If this happens, the plates which are to be found on the big end of the connecting-rod should be altered to reduce the compression. It should scarcely be necessary to point out that inlet and outlet valves should be taken out and ground in regularly. Prompt action often saves break-downs and minimizes repair bills.

A FORMULA for calculating the horse-power of spiral conveyors is as follows:

$$\text{Hp.} = C\ W\ L \div 33{,}000$$

When $C =$ constant 0.33 for grain, 0.65 for coal, and 1.0 for heavier and sticky materials; $W =$ weight for material conveyed in pounds per hour; and $L =$ length of conveyor in feet.

Engineers' Note Book

The Heating of Cables Carrying Current

By SAUL DUSHMAN

The current-carrying capacity of an insulated cable may be calculated from data on the thermal resistivity of the insulation and of the surface. It has been shown that such data may be obtained for any type of insulation from experiments on the cable itself, by applying a well known method for determining neat conductivities. As a result of experiments on different types of cable insulation, the following values have been obtained for the thermal resistivities (°C. per watt per inch cube):

Rubber and cotton braid cover	250
Varnished cambric and cotton braid cover	400
Varnished cambric (lead-covered cables)	300

For the surface resistivities, the following values were obtained (°C. per watt per square inch):

Painted steel braided armor	100
Cotton covering	120
Lead, ordinary	190
Lead, painted dull black	140

These data have been used to calculate the carrying capacities of standard rubber and varnished cambric insulated cables in air. It has been shown that the current density (i/s) and the ratio of the outside diameter (D) to the cross-section (S) are connected by an equation of the form

$$\log\left(\frac{i}{S}\right) = N \log\left(\frac{D}{S}\right) + B$$

where N is a constant for any type of in-

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sulation, and B depends upon the temperature rise.

The effect of the surface resistance on the carrying capacity has been shown to be much greater, in general, than that of the internal thermal resistance of the insulation. The magnitude of the surface losses is thus of great importance in determining the current-carrying capacities of cables.—*Proc. Am. Inst. E. E.*

Friction Losses in a Check Valve

By C. B. BUERGER

Tests to determine a frictional loss of head in a pipe-line, due to check valves, have recently been conducted, and the accompanying formula was derived from the data thus obtained. The valve tested was of the multiple spring-valve type, 18 in. diameter, and the body of the valve was 23 in. face to face of flanges. The middle section was increased in area, and a middle plate carried a number of ordinary rubber pump valves, held to the ribbed brass seats by the usual helical springs. The net clear area through the valve seats was 225 sq. in., giving the same velocity through this section as at the inlet and outlet ends.

The quantity of water passing through the valve was measured by a portable pitometer placed in a suitable straight run of pipe about 700 ft. from the valve. A special traverse was made of the pipe, and the instrument was in the hands of an experienced observer. The pressures were read on a Bourdon-type pressure gauge, with a ¼-in. pipe connection to points above and below the check valve, and a single gauge was used for both points to eliminate the instrumental error.

The readings obtained were plotted, and a curve drawn through the points, representing a fair, not a mathematical, average. This curve follows the law

$$h = 1.0 + 0.063\ v^2$$

where h is the loss of pressure through the valve, and v is the velocity of the water passing through. Or, in a slightly different form,

$$h = 1.0 + 4\ (v^2/2\ g)$$

The constant loss 1.0 represents probably the initial resistance of the valve spring. The second part of the valve is four times the velocity head, and of this probably one velocity head is the loss in the body of the check valve, and three times the velocity head the loss through the rubber and brass valves in the valve plate.—*Engineering Record.*

The Melting Point of Firebricks and Clays

The Bureau of Standards recently determined the melting points of firebricks. The results are of much interest as indicating the commercial value, as far as heat-resisting properties are concerned, of the various kinds of firebricks. The following results were obtained:

	No. of samples tested.	Melting point, °C.
Fireclay brick	41	1555 to 1725
Bauxite brick	8	1565 to 1785
Silica brick	3	1700 to 1705
Chromite brick	1	2050
Magnesia brick	1	2165
Kaolin	3	1735 to 1740
Bauxite	1	1820
Bauxite clay	1	1795
Chromite	1	2180
Pure alumina	1	2010
Pure silica	1	1750
Carborundum	1	2700

The value of 1750° given for silica is not the true melting point, but represents the temperature at which the silica flows distinctly. It was found that silicon carbide does not melt below 2700°, and becomes unstable at much lower temperatures.

Amount of Cement for Concrete

Mr. Stanley Macomber, city engineer of Centralia, Washington, states that a number of engineers in Washington are using clauses similar to the following in connection with their specifications for concrete work:

Every cubic yard of concrete 1:3:6 mixture shall contain at least 4 sacks of cement.

Every cubic yard of concrete 1:3:5 mixture shall contain at least 4½ sacks of cement.

Every cubic yard of concrete 1:1:1 mixture shall contain at least 12 sacks of cement.

Every 2 cu. ft. of top mixture 1:2 shall contain at least 1 sack of cement.

For cement over this amount nothing will be paid the contractor.

The price of all cement under the above amount shall be deducted from the total sum due to the contractor.—*Iowa Engineer.*

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Book Reviews

PRINCIPLES OF IRRIGATION ENGINEERING.* By F. H. Newell and D. H. Murphy. McGraw-Hill Book Co., New York. P. 286. Index. For sale by *Mining and Scientific Press*, San Francisco. Price $3.

There is nothing in the world of engineering practice more modern, varied, or extensive than the irrigation systems installed by the United States Reclamation Service. When two of the leading spirits in the development of this service place the essence of their experience in the selection, erection, and operation of these systems before us, it may be safely assumed as the last and best word on the subject. While it is the intent of the authors to make this work so simple as to be interesting to the lay reader, it presents all of the essentials that are required by the student and the practitioner. The whole subject is treated in nineteen chapters clearly and concisely, is exceptionally instructive to the engineer searching for practical guidance, and entertaining to the man who may be interested aside from an engineering standpoint.

The first three chapters are devoted to the preliminary stages leading up to the actual works required, and each step in the design is described in logical sequence. The illustrations typify the best of each class of works now in use in the service, and illustrate methods of design that have only been known to irrigation practice since the advent of the Reclamation Service. The high class and permanence of the works of the Reclamation Service are clearly shown and form a striking contrast with the older primitive works of the early irrigation systems. The wide experience of the authors in the supervision of the design of works of this class makes this work final and authoritative.

Drainage, a subject that has been sadly neglected in connection with irrigation, is given due consideration and is treated as dealing with differing soils and methods of irrigation. The chapters on operation and maintenance cover irrigation practice based upon present-day experiences in arid regions. Chapters ten to seventeen are devoted to storage works, dams, and outlet works, while storage supply and capacity analysis, seepage, and evaporation losses and cost of storage are discussed at length. Reservoir and dam sites are given due attention, and all types of dams, timber, earth, rock, fill, masonry, concrete-steel, and multiple arched are briefly presented. The authors bring out many of the inherent weaknesses of the older types of dams that have been considered in the past as being the most secure and safe, and also point the way of progress to the ultimate scientific type, the multiple arched dam. It is to be regretted that the data on the perfected form of this type of dam was not available to the authors at the time the book was written. Under this heading the authors suggest that this type of dam offers a possible solution of the dam problem instead of embodying a statement that it actually has proved a positive success as is shown by the results obtained from the multiple arched dams in service at Hume lake and Big Bear valley, California. It is encouraging to have the statement made by such authorities that "In other words, we may design a structure upon thoroughly scientific lines and without the unnecessary waste of material which is found in the usual solid dam. These multiple arch or composite dams are especially suitable for conditions where economy of material is a prime requisite or where the foundations are of somewhat doubtful character." These statements by the authors are borne out by my experience, and further that this eliminates most of the difficulties inherent in the older types.

The book closes with a chapter on water rights and the economic features of irrigation that will be of excellent service in clarifying an understanding of titles to the use of water and save much disappointment to prospective investors in irrigation projects.

On the whole, the 'Principles of Irrigation Engineering' is a very valuable addition to the present literature on the subject, both as a textbook and as a work of reference for engineers and irrigation investors and should be appreciated as such.

COMMERCIAL RELATIONS OF THE UNITED STATES. A concise volume, which contains statistics showing the foreign trade of each country of the world during 1911 compared with the previous year, has just been issued by the Bureau of Foreign and Domestic Commerce at Washington.

*Reviewed by John S. Eastwood, Consulting Engineer, Hearst Bdg., San Francisco.

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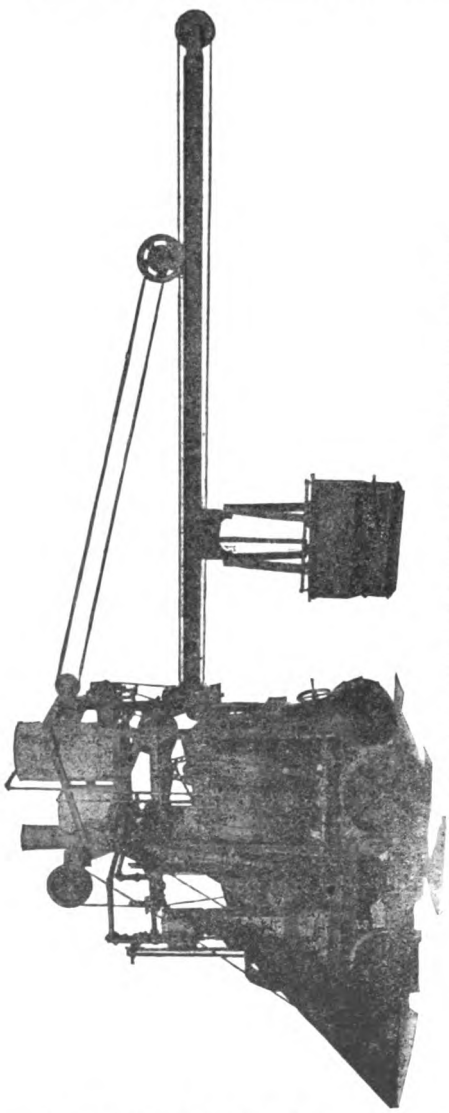
Industrial Progress

Chain Belt Paving Mixer

A new type of concrete mixer specially designed for street paving has been perfected and placed upon the market by the Chain Belt Co. of Milwaukee.

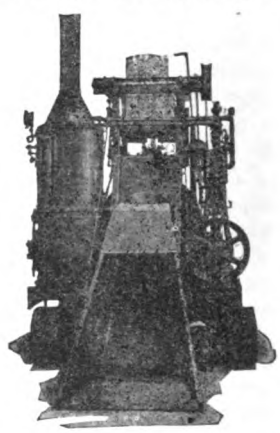
The mixer is the same general design



CHAIN BELT PAVING MIXER, SHOWING BOOM AND DELIVERY BUCKET.

as the standard side discharge mixer. The street-paver has a chain belt drive, cast semi-steel bulge drum, chilled rollers with bronze bushings, all steel frame, etc. This machine is especially designed for laying concrete pavements, but it can be used for any class of work, and is well adapted for mixing concrete for bridge abutments, etc. It is provided with a reversible traction drive so that the mixer can be moved forward or backward by its own power. The traction drive is fitted with a friction clutch. To move the machine ahead it is only necessary to throw in the clutch, and to stop the machine, throw out the clutch. The traction drive is connected to both rear wheels and is sufficiently powerful to propel the machine up an incline of 15 degrees.

The front axle is of the automobile steering knuckle-joint type, and the rear axle is a compensating differential. The latter is advantageous in that it will equalize the speed of the rear wheels in turning corners. The wheels are heavy crucible steel castings 9 in. wide. No platforms or runways are required, and if the



CHAIN BELT PAVING MIXER, FEED END.

material is placed sufficiently close to the machine, it can be shoveled directly from the supply pile to the open-end power-loader bucket. The levers are so arranged that one man can operate the entire machine if necessary. The operator stands on a platform on one side of the machine, about 30 in. above the ground, and can operate the power loader, water tank, discharge, and boom. The Chain Belt paver is capable of turning out a batch of concrete in 45 seconds.

The street-paver is equipped with a boom 20 ft. long and a delivery bucket. Paving contractors have found this the most economical method of spreading concrete on the streets as it eliminates the use of wheelbarrows and carts. The concrete is

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discharged from the mixer into the delivery bucket, which travels on a single boom. The boom can be swung at an angle of 180°, and a street 50 ft. wide can be easily taken care of. The boom bucket will hold a full batch of mixed concrete and is provided with an automatic tripper, and the gate opens automatically. The same man who operates the mixer levers also controls the movements of the boom and bucket.

In work where the road is less than 18 ft. in width, a gravity swivel chute may be substituted for the distributing boom.

National Steel Tubing

An interesting though unexpected test of steel casing manufactured by the National Tube Co. took place recently, concerning which the consumer, in writing about this casing, advised as follows:

"We recently shipped you a joint of $5\,^{3}/_{16}$-in. casing for inspection. This joint was part of a liner which we placed in a well near Gore, Ohio, after same had been completed and shot. We decided to give the well a second shot and placed in it 150 quarts of nitroglycerine with a 20-quart anchor shot. We then pulled the liner, and after getting it out we discovered that one joint was still in the hole. We decided to put the shot off with the hope that the joint of liner would come out the following shot. It, however, lodged about 1500 ft. from the top and after working with it for some few days we were able to put a bell socket over it and brought the joint out in the condition that you have found it. Would say that this well was 3000 ft. deep, and the 6⅝-in. casing was not damaged in any way."

It will be noted that the length of casing which is normally about 18 to 20 ft. was compressed to a length of about 8 ft., but careful examination will show no fracture in the material, notwithstanding the enormous strain to which it was subjected. We believe this demonstrates the fact that the material which enters into 'National' pipe is of the highest quality, otherwise it would not stand such unusual and severe punishment and distortion as is shown in this case.

Corrugated Iron Pipe *

Many culverts are now being constructed of corrugated pipe made of pure iron. The corrugations make the use of relatively thin metal possible without danger of collapse, and it is claimed that the pure iron of which the pipe is made offers superior resistance to corrosion. As far as is known, these culverts are proving generally satisfactory, but since they have been in use only a comparatively short time, their claim to durability under service conditions has not yet been fully established. It may be stated, however, that tests made on iron by the Office of Public Roads have uniformly indicated that segregated impurities present in iron affect its power to resist corrosion in a marked degree. The tests of the Office of Public Roads, in fact, formed the basis for the development of the pure-iron industry.

Corrugated iron culvert pipe should be laid in the same manner as vitrified clay and cast iron pipe. Table gives dimensions, weights, and prices as furnished by a leading manufacturer of pure iron corrugated culvert pipe and is representative. The prices are f.o.b. factory and are subject to variations.

PURE IRON CORRUGATED CULVERT PIPE

Diameter, inches.	Gauge No.	Weight per lin. ft., lb.	Price, lin. ft., net.†
10	16	9	$0.80
12	16	11	0.90
15	16	13	1.00
18	16	16	1.25
20	16	20	1.40
24	14	25	1.75
30	14	30	2.50
36	14	38	3.40
42	14	45	4.50
48	14	52	4.50

*From Bulletin No. 45, U. S. Dept. of Agriculture.

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Discussion

Wood v. Concrete

The Editor:

Sir—In the July number of *Western Engineering* is an article by Mr. Jerome Newman (M. Am. Soc. C. E.), chief engineer of the Board of State Harbor Commissioners, San Francisco, on the 'Wharf and Dock Construction in San Francisco Harbor.'

That article, while dealing mainly with a description of the harbor improvements planned and made under the last bond issue, contains a short paragraph which, in the light of Mr. Newman's recent address before the San Francisco Association of the American Society of Civil Engineers, is in more ways than one a veritable 'nigger in the woodpile.' The paragraph to which I refer reads as follows:

"Assuming the cost of a creosoted pile pier at $1 per square foot, with a life of twelve years, and that of a reinforced concrete pier at $3.25 per square foot, with a life of one hundred years, the comparative annual charges for the two types of construction are approximately as follows:

	Creosoted pile.	Reinforced concrete.
Interest at 4½%	$0.0450	$0.1463
Maintenance, assumed	0.0500	0.0125
Replacement, 12 years	0.0681	.....
Sinking fund, 75 years	0.0022	0.0077
Insurance	0.0060	.....
Total per square foot	$0.1719	$0.1665

This would indicate that the annual cost is very nearly the same for the two classes."

While all of Mr. Newman's contribution is very interesting and instructive, and as such is more than welcome both to engineers and to the public, the *raison d'etre* for the whole article seems to be in that small paragraph.

That there would be a change in the construction policy of the Commission, of which Mr. Newman is chief engineer, has been generally known among engineers since Mr. Newman's address, referred to above, given before the bimonthly meeting of the Association in April. This change, as then announced by Mr. Newman, was the abandonment of the present permanent type of construction for wharves and a reversion to the old temporary wooden construction previously condemned by long experience.

The reasons given for this reversion are:

1. With permanent construction, inability to have sufficient accommodation available in 1915 to satisfy the expected increase in shipping when the Panama canal is opened.

2. Annual cost with wood construction about the same as for concrete construction.

With regard to the first reason, the question arises: Are the temporary relief periods afforded by the wood structures followed by frequent periods of congestion when the replacement of these structures is taking place, better than a short period of congestion necessitated by the uncompleted concrete structures, followed by permanent relief, and an established capacity for handling the over-sea trade? It seems to me that we are using the slogan of '1915' a little too frequently when we apply it as an excuse for the temporary construction of public works, the completion of which is not in any way pertinent or necessary to the Exposition. Also, it does not seem likely that there will be an overwhelming rush of shipping to this port immediately on the opening of the Panama canal. The increased trade will, I believe, be a matter of growth and development; a matter of time, short perhaps, but long enough for us to cope with the demands and yet build permanently.

The second reason as given by Mr. Newman in his address was based on the figures above quoted. At present I am not going to cavil at Mr. Newman's annual charges, which are substantially correct—as far as they go. Granting his first cost and other assumptions to be correct, and making minor corrections in addition, etc., the annual charges per square foot are:

	Creosoted pile.	Reinforced concrete.
Interest on first cost of 4½% of $1	$0.0450-of	$3.25-$0.1463
Maintenance assumed	0.0500	0.0125
Replacement Fund—yearly sum invested at 4% compound interest amounting to $1 in 12 years	0.06656	.....
Sinking Fund, 75 yr. at 4%	0.0022	0.0072
Insurance	0.0060	.....
Total per sq. ft.	$0.1698	$0.1660
Difference in favor of concrete	$0.004	

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But is this a fair basis of comparison? True, the interest must be paid during the life of the bonds, namely, 75 years; but what about the years following? The life of a properly built concrete structure is generally conceded to be at least 100 years, but is actually indefinite. If it lasts 100 years it will probably last a good deal longer—that is the reason, no doubt, why Mr. Newman does not figure in any replacement fund for the reinforced concrete.

Note that the interest on first cost is the principal item in the cost of the reinforced structure. The interest on first cost in both cases ceases after 75 years, being paid off by the accumulated sinking fund, which is also eliminated. Taking the life of the concrete structure at 100 years, for the last 25 years the annual cost of each structure will be:

	Creosoted pile.	Reinforced concrete.
Maintenance assumed	$0.0500	$0.0125
Replacement, 12 yr.	0.0666	.....
Insurance	0.0060	.....
Total annual cost per sq. ft. for last 25 yr.	$0.1226	$0.0125

Difference in favor of concrete, $0.1101 per square foot.

There is yet another item which has been ignored in the comparison (although Mr. Newman mentioned it in his address before the Association) and which should be allowed for, if the comparison between the two types of construction is to be a fair one. I refer to the loss of revenue occasioned by the necessary periodical construction of the creosoted-pile type of structure.

Taking a wharf 200 by 800 ft., with an annual rental of say $25,000, and allowing six months for its replacement once in twelve years, there will be a loss of revenue of $12,500 every twelve years, or, with eight replacements, a loss of $100,000 in one hundred years. If this is taken care of by a sinking fund, the comparison follows:

	Annual cost.	100-year cost.	Av. ann. cost for 100 years.
Creosoted Pile Construction			
Interest, 75 years, at 4½%	$0.0450	$3.375	$0.0337
Maintenance assumed	0.0500	5.000	0.0500
Replacement (12 years)	0.06656	6.656	0.0666
Sinking fund (75 years)	0.00223	0.167	0.0017
Loss of revenue fund (12 years)	0.0052	0.519	0.0052
Insurance	0.0060	0.600	0.0060
Total cost per square foot	$0.1750	$16.317	$0.1632
Reinforced Concrete Construction			
Interest, 75 years at 4½%	$0.1463	$10.973	$0.1097
Maintenance assumed	0.0125	1.250	0.0125
Replacement, 100 years	0.0026	0.260	0.0026
Sinking fund, 75 years	0.0072	0.720	0.0072
Total cost per square foot	$0.1686	$13.203	$0.1320

It will be observed that in making this comparison no account has been made for the probable advance in lumber prices, which would increase the cost of the wooden structure, and also that a replacement fund has been allowed for the concrete structure, which Mr. Newman has not done. Even with this additional charge, the average annual cost during the 100 years shows a balance in favor of concrete construction of 3.12c. per square foot per year.

At first sight, 3.12c. may not seem a very great difference, but a square foot is a small unit, and when we consider that each of the 13 wharves to be constructed has from 75,000 to 160,000 square feet of surface—say an average of 130,000 square feet—there will be an average annual saving during the hundred years of $52,728. Fifty-three thousand dollars is the interest at 4% on $1,325,000, which represents the price that the public is going to pay for the privilege of feeding the teredo during the next one hundred years.

It may have been decided, however, that cost is not the governing factor and that the possible change in over-sea carriers and in freight-handling methods do not justify building for posterity.

NORMAN M. HALCOMBE.

San Francisco, August 12.

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The Editor:

Sir—The article contributed by me in the July number of *Western Engineering* has been criticized by Norman M. Halcombe, the criticism, which is based on a comparison of assumed annual cost of piers built of creosoted piling *versus* those built of reinforced concrete, being directed against the policy of adopting the former type of construction.

The comparison made by Mr. Halcombe is interesting, and the criticism would appear deserved were the assumptions absolutely correct and were cost the only consideration. That there are other factors to be taken into account in deciding on the type of construction is virtually admitted by Mr. Halcombe in the closing paragraph of his article, and in my opinion these other factors are of sufficient weight to tip the scale in favor of creosoted pile or temporary construction.

In the first place, the assumption of 12 years' life for creosoted piling and 100 years for reinforced concrete is hardly justified, though, it is true, in the article referred to above, I adopted it in making a comparison, merely to indicate in a general way that the annual cost of the two types is nearly equal under unfavorable conditions for the temporary type. There is evidence at hand to prove that properly treated piles may be counted on for a maximum life of 20 years in San Francisco bay, and 15 years may be considered a fair average; our experience with reinforced concrete has been too short, however, to enable us to form an intelligent opinion as to its durability when exposed to salt water.

Cement authorities are generally agreed that sea water acts injuriously on concrete, though the chemical combinations are not clearly understood, and it is assumed that this action is diminished or entirely prevented by making the concrete as dense as possible; this has not been positively proved, and in the absence of definite knowledge on this subject, and in view of several unexplained failures of this class of construction, it would seem unwise to expend large sums on piers of this character until more experience has been obtained. There are at present completed and under construction on the San Francisco waterfront nine reinforced concrete piers, and a study of the behavior of these will furnish information on which to base a decision hereafter as to the type of piers best adapted for use. Any comparison made at the present time which is founded on an assumed life of so-called permanent construction is valueless, and Mr. Halcombe's assertion that $1,325,000 will be spent unwisely if timber piers are built is purely academic; it may or may not be true, nobody can say, and it seems better business judgment to risk this amount than to take chances of losing a much greater investment.

Even weightier than the above is the reason mentioned by Mr. Halcombe, "That the possible changes in over-sea carriers and in freight-handling methods do not justify building for posterity, and that the heavy permanent construction used for some of the piers might not be adapted to new conditions." It is probable that conditions at this port will change materially after the opening of the Panama canal, slowly perhaps, but surely, and a pier built now will most likely be found unsuitable in a relatively short time, rendering reconstruction necessary, which is a tedious and expensive process with a concrete structure, but comparatively rapid and inexpensive with one of timber. Is it not better to wait until conditions have become settled than to build piers which may be practically useless long before they are worn out? While the influence of the opening of the Panama canal on the commerce of the port may be overestimated, we dare not risk being caught unprepared, and with the time and money at our disposal the construction of concrete piers is out of the question; but when the temporary wooden piers have outlived tneir usefulness, we shall be able to form an opinion as to the permanency of the concrete structures then in existence and to design others to fit conditions.

A concrete pier, being comparatively inelastic, would probably be damaged to a greater extent than a wooden pier by the impact of vessels entering and lying alongside. While the work being done on these structures at present is good, and special efforts are being made to obtain as dense a mixture as possible, the shocks due to this cause might cause cracks with consequent destruction of the concrete and steel reinforcement, added to which is the danger of earthquakes, the effect of which would undoubtedly prove disastrous.

On the whole, it seems to me, in the present state of knowledge of the subject, to be more prudent to adhere to a type of construction from which we know what to

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expect than to adopt one which has as yet not been tested sufficiently; while the latter may be better, let us wait until we know positively that it is so before spending large amounts thereon. JEROME NEWMAN.

San Francisco, August 30.

[A difference of opinion not only makes trade, but is a very effective 'first aid' toward the solution of engineering problems. Thorough discussion in which every feature pro and con may be brought out is the best possible road by which to arrive at definite conclusions. We hope that others interested in dock construction may add to what Messrs. Newman and Halcombe have written.—EDITOR.]

The Farmer and the Power Companies

The Editor:

Sir—I have read your editorial, page 87 in the August issue of *Western Engineering*, which calls attention to the need of a power and irrigation bureau and the fact that it could easily be maintained by the power companies. During the last three months I have endeavored to get the power companies to recognize the need of such a bureau. The problems which this bureau would solve are of vital interest in this state both to the welfare of the power companies and the irrigation interests. The companies most interested treat the subject with indifference. Apparently their time is taken up in discussing the financial situation and the impositions of the Railroad Commission.

In view of the attitude and interest displayed in response to the suggestion, several justifiable conclusions can be drawn, but should be withheld until the power companies have had time to consider the benefits to be derived from such an organization. The lack of interest in making plans which will lead to the establishing of a power and irrigation bureau for their own and the public's welfare at the present time is not due to the financial conditions, but were due to the policies—or rather lack of policies—in the companies' organizations. There is no logical reason, barring ignorance, for the companies not endeavoring to find out all about their own business and at the same time aiding the power consumer, who is the 'goose that lays the golden eggs.'

The sooner the electric companies accumulate reliable information on ground-waters and other irrigation waters, and how the lands must be settled and what the farmer must accomplish in order to make the agricultural field for power a permanent success, the easier it will be to deal with the public and indirectly find ready money for their improvements.

How do the local people look upon the power corporations? How many power companies in the state can go among their consumers and meet with favor in raising money for their bonds? The time is fast approaching in California when the corporations must have the good will of the public in order to serve their own best interests.

Can it be that the officers of the power companies and promoters fear a disclosure of actual facts regarding the exorbitant land values and imaginary resources upon which they are expecting returns from their investments? Can it be possible that such an innocent subject could in any way influence the sale of the power and irrigation bonds should the information reach the financial centres?

It is becoming a well known fact that a private irrigation project which is a success in California is an exception to the rule. The people most sincerely interested in the future of the state should be interested in seeing that the incoming money should be spent in cultivating the land and not merely in satisfying the promoter whose interest in the success of the farmer ends upon receipt of his commission. The whole state must appear to the visitor to be subdivided into small acreages. We find bare land, assessed at $10 per acre, held for sale at $60 per acre in large tracts. Across the road is similar land being sold at $125 per acre and upward with no improvements. The farmer who becomes dissatisfied is going to blame not only himself, but also the agent who induced him to invest his savings and the power company if it has in any way influenced his choice. The man who has a family and fails, places a serious handicap upon their future life. The colonization of lands is a more serious affair than is generally realized by the promoters. The power companies can be an important medium in protecting the newcomer and contributing to his success, and at the same time show the people in general that the prevalent 'farmer be damned' spirit is to be eliminated.

ARTHUR L. COLLINS.

San Francisco, August 30.

[We hope that others may contribute to this discussion.—EDITOR.]

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Engineering News

Petroleum

California oil dividends for July were as follows:

	Rate.	
*Amalgamated	1.25	$62,500.00
*American Petroleum, pfd.	0.50	8,755.50
*do com.	0.39⅓	39,607.00
Central	0.02	21,793.00
Columbia	0.015	51,283.36
Fullerton	0.05	30,000.00
Home (Coalinga)	0.01	1,000.00
Maricopa Queen	0.01	9,920.96
Mount Diablo	0.01	4,674.85
Pinal Dome	0.01	9,000.00
Prod. Tras.	1.50	105,000.00
Record	...	5,000.00
Rice Ranch	0.01	3,000.00
S. F. and McKittrick	0.05	4,995.00
Sauer Dough	0.01	2,992.50
Section 25	0.25	10,000.00
State Con.	0.005	2,511.55
*Union Oil	0.60	187,756.80
*United Petroleum	0.60	48,450.60
*Union Prov.	0.60	93,517.63
*West Coast	1.50	15,612.00
*Western Union	0.75	7,500.00
W. K.	...	10,000.00
Total California comp.		$734,770.75
*Mex. Petroleum, Ltd., pfd	2.00	$240,000.00
do pfd.	1.50	480,000.00
Total Mex. Petroleum, Ltd.		$720,000.00
Grand total		$1,454,770.75

*$100 par value; others $1.

The following figures on production, consumption, and field operations are issued by the Standard Oil Company of California:

	Barrels.
Stocks, June 30, 1913	46,389,669
Production, July 1913	8,573,906
	54,963,575
Consumption, July 1913	8,325,402
Stocks, July 31, 1913	46,638,173
	July.
Production	8,573,906
Consumption	8,325,402
Daily average production	276,578
Daily average consumption	268,561
Daily average surplus	8,017

FIELD OPERATIONS AND PRODUCTION FOR MONTH OF JULY 1913

Field.	Rigs completed	Wells: Drilling	Wells: Producing	Wells: Completed	Wells: Abandoned	Production, bbl.
Kern River	3	10	1663	..	..	926,590
McKittrick	4	11	314	12	..	584,666
Midway	18	83	870	27	3	2,813,167
Sunset	1	36	264	2	..	552,358
Coalinga	6	60	902	4	..	1,654,470
Watsonville	.	..	5	..	..	2,325
Arroyo Grande	.	..	....	..	..	.....
Lompoc	.	3	29	..	..	99,820
Santa Maria	.	9	191	3	..	456,475
Summerland	.	..	122	..	..	5,105
Santa Paula	2	23	331	3	2	78,525
Newhall	.	2	76	..	..	9,908
Salt Lake	1	12	296	3	..	226,054
Los Angeles	.	..	400	..	..	29,899
Whit.-Coyote	1	16	142	1	..	191,284
Puente	.	..	54	..	..	2,480
Fullerton-Brea Canyon	7	54	296	5	..	642,170
Lost Hills	5	15	80	7	..	298,210
Salinas Valley	.	2	....	..	..	.....
Repetto	.	1	....	..	..	.....
Totals	48	337	6035	67	5	8,573,906

San Francisco, Cal.—The Railroad Commission has increased the extent of the oil pipe-line investigation to include the following additional companies: Columbia Oil Producing Co., Murphy Oil Co., Pacific Pipe Line Co., Midway Gas Co., Independent Oil Producers' Agency, San Luis Obispo Mutual Oil Co., and Pinal Dome Refining Co. ——Report of the operations of the Royal Dutch-Shell interests for the year 1912 shows the activities of the company in the Ural-Caspian fields, Oklahoma fields, Mexico, Rumania, Dutch Indies, Sumatra, Perlak, Borneo, Java, Ceram, Djembi, Sarawak, New Zealand, and Trinidad. The company operates in Oklahoma under the name of the Gravenhage Syndicate, Ltd., and has a daily production of 3000 bbl. The ordinary capital of the company during 1912 was increased from $13,750,000 to $17,500,000, and the usual company dividends of 30% were paid on the larger amount. The reserve fund has increased from $5,600,000 to $15,000,000. The company owns approximately

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20,000 acres of oil land in Mexico, where operations are conducted in the name of Petroleum Maatschappji, which has a capital of $2,000,000. Six tank-steamers and Diesel-motor ship were added to the fleet in 1912. When these vessels are completed, the company will own 64 vessels with a capacity of 185,583 tons registered. The stockholders of the company have authorized an increase in capital of $25,000,000, in order that the company might have funds on hand for the purchase of any desirable properties that might be offered.——The United Oil Co. has levied an assessment of 5c. per share on its stock.——It has been announced that hereafter the Union Oil Co. will pay dividends semi-annually instead of monthly.——Rumors that the General Petroleum Co. has entered the Independent Producers' Agency lack confirmation.——The Independent Producers' Agency will distribute to its members at the rate of 36c. per barrel of oil for the month of June.——William H. Stilson, of Los Angeles, is conducting experiments for a process for raising the gravity of oil. It is stated that oil of 14°B. from the Mascot property at Midway has been raised 11° to 12° with an accompanying loss of 5%.——The Santa Maria Oilfields, Ltd., has added 13,320 acres to its holdings in Cat Canyon and adjoining regions. The new holdings in detail are as follows: The 80-acre lease on the Fulger ranch, upon which the Fulger Ranch Oil Co. is drilling one well, now in oil 2500 ft.; 240 acres additional, being the balance of the east half of Section 3, 9-33, of the Fulger ranch; the 1000-acre lease on the Shaw ranch, held by the Shaw Ranch Oil Co., and the La Laguna Rancho, consisting of about 12,000 acres, near Los Olivos.——It has been reported that fuel oil has been offered at Los Angeles at 60c. per barrel, which is 5c. less than prevailing prices. It is stated that this cut has been made to meet competition due to the commencement of operations by the General Pipe Line Co.——In an interview with Eugene de Sabla, president of the General Petroleum Co., the following statement was made as to the condition of his property: "Two independent experts who have recently completed a thorough examination of all the company's properties in California and in Mexico place their total valuation at $40,000,000. Against this total we have outstanding a total funded debt, including bonds deposited as securities for our note issue, of about $20,000,000. Our total floating indebtedness of all kinds amounts to $1,250,000. This includes the amounts payable under the Stewart option and everything. Our quick assets, such as oil in storage, accounts receivable, etc., is about sufficient to cover our floating indebtedness, including $333,000, the payment yet due the Stewart option, payable $33,000 per month. The production of our wells now averages from 14,000 to 15,000 bbl. per day. The company's present producing wells are as follows: Midway, 98; Lost Hills, 11; Belridge, 10; Coalinga, 14; Fullerton, 33; total, 166. The average cost of an oil well in California is about $15,000, so that these 166 wells, without pipe-lines, refineries, or anything else, represent an expenditure of about $24,000,000."

The Standard Oil Co. has filed with the Railroad Commission the following rates and conditions of acceptance for the transportation of oil by pipe-line.

TENTATIVE RATES

From—	Minimum gravity.	Cts. bbl. 42 gal.
Signa station to Richmond	15	35
Midway station to Richmond	15	35
Lost Hills to Richmond	18	35
Wait (Kern) to Richmond	15	35
Coalinga to Richmond	18	35
Northam to El Segundo	18	8
Orcutt to Port San Luis	18	16
Pico Canyon to Ventura	22	18

CONDITIONS OF ACCEPTANCE

1. It will receive crude petroleum at points shown above in lots of not less than 100,000 bbl. of the same kind and gravity, all of which shall be consigned for delivery to the same delivery point.

2. Crude petroleum containing qualities injurious to other crude oil in contact therewith will not be received for transportation.

3. All such crude petroleum will be accepted for transportation only on condition that it shall be subject to such changes in kind and gravity while in transit as may result from the mixture of said crude petroleum with other crude petroleum in the pipe-lines or tanks of this company.

4. It will charge transportation on net oil received and deliver an equal quantity of net oil, less 2% to cover transportation losses.

5. It will charge storage of one-fourth of one cent (¼ of 1c.) per barrel per day commencing 24 hours after written notice to

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shipper that his crude petroleum has reached destination. No oil will be stored longer than 10 days, and unless taken by the shipper upon the expiration of that time it will be sold for transportation, storage, and other charges.

6. It will not be liable for any loss of crude petroleum caused by the act of God, the public enemy, authority of law, fire (whether caused by explosion, by spontaneous combustion, or otherwise), or for loss from causes beyond the control of the company, and such loss shall be deducted pro rata from all crude petroleum in course of transportation (including oil in storage) at the time of such loss, and transportation and accrued storage charges shall be paid on the amount of crude petroleum so deducted.

7. Orders for shipment from the producer shall become operative in the order in which they shall have been received.

8. Crude petroleum will only be accepted for transportation when free from all liens and charges, and all charges on account of transportation and storage of crude petroleum will be a lien against the crude petroleum until paid.

9. Crude petroleum will not be received for transportation on Sundays or legal holidays.

Los Angeles, Cal.—The American Gas Co., organized by W. R. Rowland and T. W. Okey, connected with the Puente Oil Co., has leased the natural gas output of the Berkshire wells, in the old Santa Maria fields, for the purpose of manufacturing casing-head gasoline. A new process has been invented by Mr. Okey and the first plant will be put in for experimental purposes.——The General Petroleum Co. has reported the following results of drilling by electricity in the West Side fields: Well No. 22, in the Belridge district, was drilled to a depth of about 1800 ft., using a General Electric drilling motor, and the cost of drilling was less than $75. It is stated that this cost is far below that of steam and that the well was handled with much greater ease and less danger. Well No. 31 will be drilled by the same methods.——The new plant of the Olinda Gasoline Co. has commenced operation. A new process, the invention of W. C. Cutler, of Sawtelle, is used. The gasoline is produced by a combination of refrigeration and pressure whereby the natural pressure of the well is used. It is expected that 2500 gal. of gasoline will be produced from 1,000,000 cu. ft. of gas.

Miscellaneous Engineering Construction

Los Angeles, Cal.—A contract has been awarded by the Santa Fe Railroad to the Van Sant-Houghton Co. of San Francisco for the construction of a 25-stall roundhouse.——The Board of Public Works has awarded a contract to C. D. Crouch for disposing of the city's garbage at 51c. per ton. Mr. Crouch will build a disposal plant at a cost of $250,000.

Huntington Beach, Cal.—Plans for a new sewer system and septic tank have been completed by Mr. Fountain, city engineer. Estimated total cost is $29,000. A bond election is to be called.

San Francisco, Cal.—The Board of Works has let a contract to the C. A. Blume Contracting Co. for erecting 7500 tons of steel for the new city hall, at a price of $10.60 per ton.

Vallejo, Cal.—Secretary of the Navy has rejected all bids for dredging Mare Island channel. New bids have been called for, to be opened on September 8.

Napa, Cal.—A contract has been awarded to J. B. Newman for the erection of a 3-span stone bridge at a price of $6000.

San Rafael, Cal.—The proposed bond issue for various municipal improvements has been ratified by the voters; $100,000 is to be expended for street improvements, $40,000 for dredging and widening San Rafael canal, $25,000 for a municipal park and bathhouse, $25,000 for a street repairing station, and $25,000 for a garbage incinerator.

Walnut Grove, Cal.—The federal government, through the U. S. Engineer's Office, will expend $300,000 for widening the mouth of the Mokelumne river.

Red Bluff, Cal.—A contract has been entered into between Los Molinos Construction Co. and George A. Clark to build a reinforced concrete overflow dam in Mill creek.

Redding, Cal.—The county Board of Supervistors has let a contract to William Stevens for building a 160-ft. steel bridge at a price of $7225.

Gridley, Cal.—The city Board of Trustees has decided to readvertise for bids for the construction of a sewer system. Mr. Castner is city engineer.

Arbuckle, Cal.—The Board of Supervisors

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has advertised for bids for the construction of a 680-ft. wooden bridge east of College City, a reinforced concrete bridge across Sycamore, and 16 spans of a reinforced concrete bridge on the Colusa-Maxwell road.

Oroville, Cal.—The Board of Supervisors has let bridge contracts for three bridges near Chico, the total cost of which will be $5792.20. A. A. Plagge will construct the Rock Creek bridge at a cost of $3125, the Chico Construction Co. received the contract for the Keifer bridge at a cost of $1289, and the Sand Creek bridge at $1378.

Sacramento, Cal.—The city clerk has been authorized to advertise for bids to construct sections 2, 4, 7, and 8 of the new city levee system at a cost in excess of $500,000.——A contract has been let by the city to C. F. Braun & Co., of San Francisco, for a 450-hp., direct-connected, steam-turbine driven Alberger pump, having a capacity of 15,000,000 gal. per day; price $17,000.——The Board of Supervisors has decided to rescind its action in awarding contract for the concrete bridge across the American river to the Ross Construction Co., and will readvertise for bids to be opened on September 12.

Reno, Nev.—The Stone & Webster Corporation will construct a dam across the outlet of Lake Tahoe at a cost of $40,000.

Oregon City, Ore.—Plans and specifications for trunk sewer and laterals have been completed. Charles S. Noble is city engineer.

Spokane, Wash.—Contract has been let to Hartness & Norris for the construction of the Trent viaduct at a cost of $18,748. The viaduct was designed by J. W. Strack, city engineer.——The Spokane, Portland & Seattle Railway Co. has awarded the following contracts: Guthrie-McDougall Co. received contract for bridges at Brickyard gulch, for 5000 yards of concrete at $10 per yard. Le Doux & Le Doux, of Portland, secured the contract for bridges over Seventh avenue, Woodlawn boulevard, and Fifteenth avenue, amounting to about $20,000. Campbell & Hartman, of Portland, were awarded a contract for concrete abutments for steel bridges at Box canyon, Wilson canyon, and Bouvey canyon on the Snake river, amounting to $10,000.

Davenport, Wash.—The City Council will advertise for bids for a new sewer 1400 ft. long.——Contract has been let to the Coast Bridge Co. for the construction of eight bridges. The spans will vary between 100 and 60 feet.

Colfax, Wash.—A contract has been let to Weldon Vedder for the plumbing, heating, and sidewalks for the new city hall, at a price of $10,900.

Olympia, Wash.—Bids for the erection of a 125-ft. smoke stack for the Eastern Washington Hospital for the Insane have been received from Mat Brannigan, of Seattle, for a brick chimney at a cost of $6000, and from the Webber Chimney Co. of Chicago for a concrete chimney at $3090. The contract will probably be let to the latter.

Wenatchee, Wash.—A contract has been let to J. W. Quigg for repairing Columbia river wagon bridge.

Kellogg, Idaho.—Bids for the construction of the Kellogg sewer were received as follows: Rusch & Laplant, of Spokane, $20,250; Parrott Brothers Co., of Baker City, Ore., $20,400; Chas. H. Mull, of Twin Falls, $20,625.

Twin Falls, Idaho.—A wagon bridge is contemplated across Snake river at a cost of $20,000.

Salt Lake City, Utah.—A contract has been let to Owen H. Gray & Co. for the construction of the dams on the lakes at the head of Big Cottonwood canyon, at a price of $66,016.50.——Surveys have been completed for the proposed dam and reservoir in Parley's canyon.

Railways

Los Angeles, Cal.—The Los Angeles & San Joaquin Valley railroad has been incorporated with an authorized capital stock of $3,000,000, of which $148,500 has been subscribed and 10% has been paid in. The incorporators are: Thomas E. Gibbon, W. C. Shelton, J. E. Stevens, J. E. Shelton, and J. R. Colburn. It is proposed to build an electric railroad connecting Los Angeles with the San Joaquin valley over the shortest possible route. The distance will be approximately 135 miles.

Tulare, Cal.—It is stated that contract for the completion of the construction of the Big Four railroad between Tulare and Visalia has been let. The price is approximately $7000 per mile.

San Francisco, Cal.—The Sacramento Valley Electric railroad has applied to the Railroad Commission for permission to issue $6,000,000 bonds to provide funds for construction work.——The Oakland, Antioch & Eastern railroad has been authorized to issue bonds in the sum of $1,000,000 for the pur-

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pose of providing funds for paying for the construction of the line from Bay Point to Sacramento.

Salt Lake City, Utah.—It is stated that a consolidation has been effected between the Utah Coal railroad and Denver & Rio Grande railroad.——The Surprise Valley Railway Co. has been incorporated with the following officers: E. L. Perkes, president; Charles L. Rood, vice president; and H. B. Laub, secretary and treasurer. The authorized capital stock is $800,000. It is proposed to build a road 55 miles long to connect with the Western Pacific at Reynard, Nevada, to run northwesterly to the Nevada-California line. It is stated that J. E. Sexton, general manager of the Eureka railroad, with headquarters at Palisade, Nevada, will superintend construction of the new road.

Spokane, Wash.—A contract has been let to MacArthur Bros. of New York for the construction of 35 miles of railway in Canada, known as the extension of the Coalmont & Coquilhalla railroad. Price is said to be $3,500,000.

Lewiston, Idaho.—Camas Prairie railroad will expend $200,000 on various improvements at Lewiston.

Streets and Roads

Riverside, Cal.—Supervisors have adopted specifications prepared by Mr. Pearson, county surveyor, for a portland cement concrete road 6900 ft. long, which is to be built at a cost of approximately $11,000 per mile.

Los Angeles, Cal.—A contract has been let to the Barber Asphalt Co. for paving Elden avenue from San Marino street to Pico with asphalt and brick at a price of $19,765. The Fairchild, Gilmore, Wilton Co. bid $20,270; Ford & Stout bid $20,760.——A contract has been let to the Fairchild, Gilmore, Wilton Co. for grading and paving Pacific avenue in San Pedro from Wilmington and San Pedro road to 14th street at a price of $159,902.02.

Alameda, Cal.—The City Council has reported in favor of paving ten Alameda streets, using funds to be raised by a bond issue. The amount involved is about $69,000.

Martinez, Cal.—The Board of Supervisors is considering specifications for building a concrete surface on a portion of the tunnel road.

Vallejo, Cal.—The county has decided to purchase $175,000 of state highway bonds.

Napa, Cal.—The people have voted in favor of a direct tax of $10,963 for building macadam roads. Eight miles of road will be built.——The City Council has let a contract to George Serington for macadamizing Spencer street at a cost of $6100.

Willows, Cal.—A contract has been let to Michael Forman for the construction of Sanhedrin road at a price of $2890.

Ogden, Utah.—The City Commissioners have granted the petition of property owners to pave Lincoln avenue between 26th and 30th avenues with concrete.

Salt Lake City, Utah.—A contract has been let to P. J. Moran for paving 7th South street from Main to 5th East street for the sum of $60,105.80 and 5th South street from 2nd to 5th East street for the sum of $36,136.77. Utah rock asphalt will be used, Moran's bid being $1.80 per square yard. Other bids were $1.85 and $2.

Kaysville, Utah.—The Commissioners of Davis county are considering the construction of a concrete highway 27 miles long, at an estimated cost of from $5000 to $6000 per mile for a 15-ft. roadway.

Nephi, Utah.—Johnson & Stewart of Provo have commenced work on 90 blocks of paving.

La Grande, Ore.—It is announced that the new administration will consider all types of pavement in letting future contracts.

Walla Walla, Wash.—A project is under way looking toward the construction of 125 miles of concrete roads in this county. W. C. MacNown is city engineer. The estimated cost will be $10,000 per mile.

Dayton, Wash.—Fourteen miles of permanent highways have been completed during the past 12 months. Wilson McBride is county engineer.

Omak, Wash.—All bids for street pavement have been rejected and the work will be done by day labor.

Colfax, Wash.—The City Council has called for bids for paving three new districts. Warrenite is to be used.

Pullman, Wash.—A resolution has been adopted providing for the improvement of Maiden Lane and other streets embracing a total of 18 blocks of hard surface pavement. The contract has been awarded to the Warren Construction Co. for paving district No. 14.

Republic, Wash.—Bids have been advertised for grading, draining, and surfacing Ferry county permanent highway No. 1; $8736 has been appropriated to pay for this work.

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Spokane, Wash.—The County Commissioners have awarded a contract to C. Sorenson for building one mile of Sunset boulevard for $6336. A contract has been awarded to the Barber Asphalt Co. for paving Market street with bitulithic pavement with a 2-in. surface and a 4-in. concrete base. The price is $23,975.——Plans for the road connection between Sunset boulevard and the west end of Latah bridge have been sent to the Department of Public Works. Spokane bituminous No. 2 pavement will be used on a concrete base.——Preliminary survey has been completed for the proposed route of the Inland & Empire highway.——A surveyor's crew is at work on the Moran Prairie road and the preliminary survey of the Whitman county line has been completed.

Ritzville, Wash.—A movement is under way toward repaving the main and cross streets.

Olympia, Wash.—It is stated that although there is only $370,000 in the public highway fund at the present time and that there will be no more until after March 1, 1914, contracts have been let and are in contemplation for the work that will total nearly $800,000.

Moscow, Idaho.—An extensive program of street improvements has been adopted by the City Council.

Wallace, Idaho.—Contract has been let to James D. Haight for the construction of a road connecting Kingston and Enaville.

Lewiston, Idaho.—New roads are contemplated through the Lapwai valley from Culdesac to Joseph at a cost of $200,000. Eugene Booth is county engineer.

Boise, Idaho.—The State Supreme Court has declared valid the issue of $200,000 road bonds recently voted by the people.

Power, Gas, and Electricity

San Francisco, Cal.—The Pit River Power Co. has filed an application with the Railroad Commission to operate a power system to be installed at Burney falls. One thousand horse-power is to be generated at present. The following are interested in the company: William F. Blake, W. T. Jeter, J. H. Logan, and John F. Sheehan, Jr.——The Great Western Power Co. has applied for a modification of the order issued by the Commission in March, the revised estimate of expenditures being as follows: Additions and improvements to the distribution system, including pole lines, transformers, regulators, meters, etc., in the counties of Alameda, Contra Costa, Sacramento, Solano, Sonoma, and Napa, and in the cities and towns therein; cables under Carquinez straits and the bay of San Francisco, sub-station at Denverton, additions to sub-stations at Napa and Sacramento, warehouse and garage at Petaluma, equipment of office at Napa, $1,059,040.85. Addition and improvements to transmission system, including fifteen miles of tower line; sub-station at Antioch, additions to sub-station at Cowell, Clayton, and Brighton, $145,312. Additions and improvements to the production system, including the completion of the Big Bend development, synchronous condenser at Oakland steam plant, $685,727. Additions and improvements to the lands appurtenant to the hydro-electric development, including acquisition of lands in Big Meadows, $200,000. Additions and improvements for general utility purposes, including cable barge, $18,300. Completion of gravity section type dam at Big Meadows, $1,607,635. Reimbursement for capital expenditures, $280,783.——The Oro Electric Corporation has been denied a re-hearing of its application to enter the city of Stockton. ——The H. G. Lacey Co. of Hanford has applied for permission to issue $20,000 in promissory notes.——J. Frank Jackson, who owns a water system at San Martin, Santa Clara county, has been directed to install meters. ——The Secretary of Agriculture has approved the issuance of a permit to the Oro Electric Corporation for its power-plant in the Plumas National Forest.

Lodi, Cal.—A project is under way for the purchase by the municipality of the gas plant owned by H. C. Keyes.

Marysville, Cal.—The Pacific Gas & Electric Co. will install a new gas holder of 150,000 cu. ft. capacity to cost about $25,000.

Salt Lake City, Utah.—A movement is under way, looking toward the construction by the municipality of an electric light plant in City Brick canyon.——Construction work has been commenced by the Uath Power & Light Co. on a new distributing station to cost $2,000,000.

Ogden, Utah.—A construction crew has commenced work on two 110,000-volt transmission lines.

La Grande, Ore.—A contract has been let to Hulme & Spaeth for the installation of a heating plant at the Central school building, the price to be $5887.

Olympia, Wash.—The Spokane Valley Power Co. has been incorporated with an authorized capital stock of $200,000. The

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incorporators are J. W. McBride, Fred A. Kragelund, L. Timberman, V. E. Bayless, and T. J. Moonach.——The City Garden Water Co., of Spokane, has been incorporated at a total capital stock of $27,600. The incorporators are Paris H. Renshaw, C. H. Cassil, and Everett H. Pattison.

North Yakima, Wash.—The Pacific Power & Light Co. has been instructed to build a reservoir in connection with its water plant supplying the city of North Yakima.

Washington, D. C.—A water-power permit has been granted recently by the Secretary of Agriculture to the Oro Electric Corporation, of California. By this permit the company is allowed to use certain lands of the Plumas National Forest, near Oroville, California, in the development of hydroelectric power. The plant provided for by this permit, together with one other, is being operated by the company in supplying power for lighting and other uses to Oroville and vicinity. To increase its power output, the company is constructing another plant on Yellow creek, a tributary to the north fork of the Feather river, and it is probable that as soon as the market demands, other water-power sites will be developed. A portion of the land needed for the Yellow creek development is within the boundaries of the Plumas National Forest. Permission to use this land was granted by the Secretary of Agriculture on March 13, 1912. Under the new permit the power is developed at what is known as the Lime Saddle plant, to which the water is conveyed by means of the Miocene and Nickerson ditches through the Kunkle reservoir. After equalization in this reservoir, it is carried to the plant by a pressure pipe about a mile long, where a static head of 478 ft. is obtained. The power-house is equipped with two 1000-kw. units, driven by two Pelton wheels at a speed of 400 r.p.m. At the generators the voltage is 2300, this being increased to 30,000 volts for transmission to the market.

Irrigation and Water Supply

Redlands, Cal.—Petitions have been received by the City Trustees to make extensions to the municipal water and lighting service.

Whittier, Cal.—The City Council has ordered the installation of water meters for all private consumers.

San Francisco, Cal.—Work has been commenced by the U. S. Reclamation Service on the Rio Vista project of flood control. Two dredges are at work and a 32,000-ft. pipeline has been installed.

Alturas, Cal.—The Secretary of the Interior has ordered the release of government lands within the Big Valley irrigation project. Work will be commenced by the Sacramento Valley Development Association, of which O. H. Miller of Sacramento is secretary.

Tehama, Cal.—An election has been called for September 16 to vote upon a proposed issue of bonds in the sum of $10,000 to provide funds for the installation of a municipal water system. The water is to be handled by a gasoline driven pump, and a 30,000-gal. steel tank is to be installed.

Marysville, Cal.—Frank Lane, C. F. Boardman, and H. R. Creps have been appointed commissioners to levy an assessment for the purpose of raising $294,800 for improvements in Reclamation District No. 876.

Montague, Cal.—Surveys have been completed and an estimate prepared for an irrigation system for the Shasta Valley Irrigation Association. T. J. Nolton is secretary.

Klamath Falls, Ore.—It is stated that a branch irrigation system is to be constructed by the U. S. Reclamation Service at this point and that an extension of time is to be granted to settlers on the Klamath Reclamation project.

Wenatchee, Wash.—A new irrigation project including 5000 acres near Bray's landing, 25 miles from this city, is under development. H. S. Goodrich of Topeka, Kansas, is promoting the project. F. C. Humphrey is agent at Wenatchee.

Pullman, Wash.—Improvements in the city water supply system are to be made at a cost of $10,000. A bond issue will be necessary to provide the funds.——The City Council has passed an ordinance ordering the installation of water meters for every private consumer.

Salt Lake City, Utah.—The city water department is considering abandoning pumping water from wells in Emigration canyon and are figuring on the construction of a tunnel farther down the canyon to tap the subterranean sources of supply in order to produce a gravity flow. C. F. Barrett is city water superintendent.——Preliminary surveys have been completed for a proposed

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branch canal to be constructed by the city in order to prevent damage to streets and private property during the season of heavy rainfall. W. J. Tuddenham is street supervisor.——A new pipe-line is to be installed from Emigration canyon to the Thirteenth East reservoir. This pipe-line will be 14 in. diameter and cost $12,000.

Ogden, Utah.—At a special election a $75,000 bond issue was approved to cover a portion of the cost of constructing the dam on the south fork of Ogden canyon. This fund will be increased to $125,000 from money on hand in the general water works fund.

Priest River, Idaho.—At a special election the proposition to issue bonds in the amount of $14,000 for the purpose of construction and maintaining a water supply system was carried.

Personal

J. W. McAfee, city engineer of Lodi, Cal., has resigned his position.

John Fellman of Red Bluff has been appointed U. S. Mineral Surveyor.

B. K. Stroud is inspecting the oilfields in the vicinity of Casper, Wyoming.

D. C. Jackling of San Francisco has been made a director of the General Petroleum Company.

Louis Albert Kling has resigned his position as Forest Supervisor at the Lassen National Forest.

A. P. Flockhart, of Melbourne, Australia, is studying California irrigation methods in behalf of the Australian Government.

R. J. Weir, assistant engineer for the Central Pacific Railway, is engaged in locating a new line from Susanville to Klamath Falls.

J. C. McQuiston and H. W. Cope, of the Westinghouse Electric & Mfg. Co. have left San Francisco for Pittsburgh via southern California.

Moncrieff Finlayson of the Indo-Burma Petroleum Co. of Rangoon, Burma, has left San Francisco for New York via Chicago and Pittsburgh.

J. P. Martin, engineer for the U. S. Forest Service, is making a general inspection of the Salmon and Weiser forests in northwestern Idaho.

H. J. Doolittle, highway engineer of Davenport, Wash., has commenced a survey for the Inland Empire highway from Spokane to Rosalia.

Franklin K. Lane, Secretary of the Interior, has inspected the work under way for the development of the Des Chutes power project in Oregon.

T. G. Cochrane, engineer for the Trinidad Oilfields, Ltd., of London, has left for home after an extensive inspection trip through the California oilfields.

Lynn Crandall, assistant engineer for the U. S. Geological Survey, is engaged in an inspection tour of the Santa Clara and Rio Virgin valleys in Utah.

W. J. Allen, Chief of the Department of Agriculture and Irrigation of New South Wales, Australia, is inspecting the various irrigation projects of California.

William E. Edens, of Chicago, president of the Illinois Highway Improvement Association, has been touring the Pacific Northwest in the interests of the good roads movement.

Alfred Noble, consulting engineer of New York, has been retained by the U. S. Navy Department, to report upon the condition of the Pearl Harbor dry dock project at Hawaii.

A. G. Folger of Sacramento, Lewis Frankenheimer and George A. Atherton of Stockton, and M. C. Zumwalt of Tulare have been appointed members of the California State Reclamation Board.

Francis V. T. Lee, one of the best known electrical engineers on the Pacific coast, died at Victoria, B. C., on Sunday, August 17. An extended review of his career will be published in the October issue.

Elmer A. Holbrook, professor of mining engineering in the Nova Scotia Technical College, Halifax, Nova Scotia, has been appointed assistant professor of mining engineering at the University of Illinois to have charge of the recently equipped coal-washing and ore-dressing laboratory and the course in mine design.

Society Meetings

The annual meeting of the American Mines Safety Association will be held at Pittsburgh, Pennsylvania, September 22 to 24, 1913.

The Engineers' Club of Seattle now has a total membership of 125. Weekly meetings are held in the form of luncheons, and visiting engineers are made cordially welcome. J. Thomas Dovey, 722 Central building, Seattle, is president.

The Engineers' Club of San Francisco, at a meeting held August 8, voted to lease permanent quarters at the Hotel Sutter, where

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dining, reading, and lounging rooms will be maintained for the accommodation of members and their guests.

The UTAH COUNTY SOCIETY OF ENGINEERS, at the organization meeting held at Provo on August 5, adopted articles of incorporation and elected the following officers: president, F. F. Wentz of Provo; vice president, F. S. Hadley of Springville; and secretary and treasurer, George C. Swan of Provo.

The fifth session of the PACIFIC LOGGING CONGRESS will be held at Spokane, Washington, September 24 to 27. The object of the Congress is the advancement of the science of logging engineering. Its field embraces British Columbia, Idaho, Montana, Washington, Oregon, and California.

Catalogues Received

NATIONAL STEAM PUMP CO., Upper Sandusky, Ohio. The National oil engine.

CHICAGO BRIDGE & IRON WORKS, Chicago, Illinois. Catalogue on water towers.

WASHINGTON PIPE & FOUNDRY CO., Tacoma, Wash. General catalogue on wood-stave pipe.

DODGE MANUFACTURING CO., Mishawaka, Indiana. Pamphlet covering main engine drives.

H. A. STRAUSS CO., Chicago, consulting engineers and contractors. Bulletin of general information.

STANDARD OIL COMPANY OF CALIFORNIA. Bulletin and monthly publication of general information.

CHICAGO PNEUMATIC TOOL CO., Chicago and New York. Catalogue No. 42, on Boyer railway speed indicator.

ROBINS CONVEYING BELT CO., New York. Bulletin No. 51. Coal and coke crushers, feeders, and elevators.

HOSKINS MANUFACTURING CO., Detroit, Michigan. Bulletin No. 3, on the Hoskins thermo-electric pyrometer.

RUGGLES MACHINE CO., Poultney, Vermont. Ruggles aerial carrier and latest improved mill and quarry equipments.

THE OTTO GAS ENGINE CO., Philadelphia. Pamphlet discussing the development of the internal-combustion engine.

J. W. HOWARD, consulting engineer, No. 1 Broadway, New York. Pamphlet on tests for high-grade paving bricks.

NEW LONDON SHIP & ENGINE CO., New London, Connecticut. Bulletin No. 1, illustrating heavy-oil marine-type engines. Bulletin No. 2, heavy-oil horizontal stationary engine.

STONE & WEBSTER ENGINEERING CORP., 147 Milk street, Boston, Mass. Illustrated book describing its water-power installations.

WEST SACRAMENTO CO., Sacramento, California. Pamphlet giving general information concerning this company's irrigated farms. A report by Haviland, Dozier & Tibbetts, consulting engineers, on great American levees.

GENERAL ELECTRIC COMPANY. New bulletins: A4116, Isolated and small plant alternating-current switchboard panels; A4102, Sewing-machine motors; A4084, Centrifugal compressors; A4061, Electric arc headlights; A4097, Ventilated motors for railway service; A4113, Oil break switches; A4110, Cloth pinions; A4035, Series luminous arc lamps; A4122, Carrier bus arc panels and brush arc generators; A4114, Oil switches known as Type F, Form K-21; A4109, Belt-driven revolving armatured alternators; A4043A, Ozonators; A4123, Automatic voltage regulators; A4129, Small feeder voltage regulators; A4121, Direct-current motors; A4127, Straight and automatic air-brake equipment.

Commercial Paragraphs

A contract has been awarded the ALLIS-CHALMERS MFG. CO. for furnishing and installing a motor-generator set for the Geary Street Municipal Railroad.

The MARINE FOUNDATION CO. has been incorporated for the purpose of placing upon the market the reinforced-concrete socket pile. Offices have been opened in the Rialto building, San Francisco. K. D. McLean is general manager.

The new Equitable Life Insurance Building in New York, 38 stories high, will contain approximately 36,000 tons of structural steel, the inspection of which, both mill and shop, has been entrusted to ROBERT W. HUNT & COMPANY.

The Seoul Mining Co. has placed an order with the WESTINGHOUSE ELECTRIC & MFG. CO. through Takata & Co., its agents in the Orient, for two 1000-kw. Westinghouse-Parsons turbo-alternators, including 2 banks of transformers, switchboard panels, Babcock & Wilcox boilers, and the usual auxiliaries. The power is to be transmitted 60 miles for use in operating the company's mills.

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